PB-240 762

# EVALUATION OF MTF FOR TESTING HAZARDOUS MATERIAL SPILL CONTROL EQUIPMENT

Charles R. Thomas, et al

Hancock County Port and Harbor Commission

Prepared for:

National Environmental Research Center
Environmental Control Corporation
Environmental Quality Systems, Incorporated

December 1974

DISTRIBUTED BY:

NTIS
National Technical Information Service
U. S. DEPARTMENT OF COMMERCE

100057

gv

**TECHNICAL REPORT DATA**
*(Please read Instructions on the reverse before completing)*

1. REPORT NO. EPA-670/2-74-073
2.
3. PB 240 762

4. TITLE AND SUBTITLE
EVALUATION OF MTF FOR TESTING HAZARDOUS MATERIAL SPILL CONTROL EQUIPMENT

5. REPORT DATE
December 1974-Issuing Date

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S) Charles R. Thomas, George M. L. Robinson (Environment Control Corp.), and Edward J. Martin (Environmental Quality Systems, Inc.)

8. PERFORMING ORGANIZATION REPORT NO.

9. PERFORMING ORGANIZATION NAME AND ADDRESS Hancock County Port and Harbor Commission, Bay St. Louis, Mississippi 39520 Through contract with Environment Control Corp., Painesville, Ohio 44077 and subcontract with Environmental Quality Systems, Inc., Rockville, Maryland 20852

10. PROGRAM ELEMENT NO.
1BB041; ROAP 21AVR; Task 03

11. ~~CONTRACT~~/GRANT NO.
S-801830

12. SPONSORING AGENCY NAME AND ADDRESS
National Environmental Research Center
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

13. TYPE OF REPORT AND PERIOD COVERED
Final Report: 6/72 - 8/74

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES The grantee, Hancock County Port and Harbor Commission, contracted for the preparation of the report with Environment Control Corp., which subcontracted with Environmental Quality Systems, Inc., for part of the work.

16. ABSTRACT

The Mississippi Test Facility (MTF), Bay St. Louis, Mississippi, is evaluated as a potential location for safely testing and demonstrating equipment designed to control hazardous materials spills. The study includes an examination of all factors, which influence the selection of an appropriate site, with special emphasis on the assured protection of the environment. Within the identified constraints, three candidate areas were selected for more detailed investigation: the Northeastern Buffer Zone, the Southeastern Buffer Zone, and the North-Central Fee Area. The report recommends the use of a 100-acre site located in the Northeastern Buffer Zone to conduct a three-phase development program. The program includes detailed initial and continuing environmental baseline monitoring, construction and operation of a semi-closed test facility, and continuing analysis and upgrading of program elements. The recommended test facility includes the following: an artificial stream channel, test ponds, landspill study areas, and supporting elements. It is recommended that the three-part program development phase be initiated within the near future, in order to meet the rapidly increasing needs for such a facility.

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
US Department of Commerce
Springfield, VA. 22151

**PRICES SUBJECT TO CHANGE**

17. KEY WORDS AND DOCUMENT ANALYSIS

| a. DESCRIPTORS | b. IDENTIFIERS/OPEN ENDED TERMS | c. COSATI Field/Group |
|---|---|---|
| *Test facilities, *Contaminants, *Decontamination, *Environmental engineering, Water pollution, Water treatment, Hazardous materials, Environments, Waste disposal, Surveys | *Test facility evaluation, Mississippi Test Facility, *Hazardous materials spills, *Hazardous materials spill control, Hazardous materials spill cleanup, Hazardous polluting substance spills, Environmental baseline survey, Comparative spill test site analysis | 13B |

18. DISTRIBUTION STATEMENT
Release to Public

19. SECURITY CLASS *(This Report)*
Unclassified

20. SECURITY CLASS *(This page)*
Unclassified

21. NO. OF PAGES
308

22. PRICE
9.25/2.25

EPA Form 2220-1 (9-73)

EPA-670/2-74-073
December 1974

# EVALUATION OF MTF FOR TESTING HAZARDOUS MATERIAL SPILL CONTROL EQUIPMENT

By

Charles R. Thomas
George M. L. Robinson
Environment Control Corporation
Painesville, Ohio 44077

and

Edward J. Martin
Environmental Quality Systems, Inc.
Rockville, Maryland 20852

Project No. S-801830
Program Element No. 1BB041

Project Officer

Peter B. Lederman
Industrial Waste Treatment Research Laboratory
Edison, New Jersey 08817

NATIONAL ENVIRONMENTAL RESEARCH CENTER
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

ia

# REVIEW NOTICE

The National Environmental Research Center--Cincinnati has reviewed this report and approved its publication. Approval does not signify that the contents necessarily reflect the views and policies of the U. S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

# FOREWORD

Man and his environment must be protected from the adverse effects of pesticides, radiation, noise and other forms of pollution, and the unwise management of solid waste. Efforts to protect the environment require a focus that recognizes the interplay between the components of our physical environment--air, water, and land. The National Environmental Research Centers provide this multidisciplinary focus through programs engaged in

- studies on the effects of environmental contaminants on man and the biosphere, and
- a search for ways to prevent contamination and to recycle valuable resources.

Pollution resulting from spills of hazardous materials is widely recognized as very damaging to the water ecosystem and to the public health and welfare. This report is an assessment of the current suitability of the Mississippi Test Facility (MTF) as a captive site where technology and equipment for the prevention, control, removal, and cleanup of spilled hazardous materials can be demonstrated and evaluated full-scale in an environmentally safe manner.

A. W. Breidenbach, Ph.D.
Director
National Environmental
Research Center--Cincinnati

# ABSTRACT

The Mississippi Test Facility (MTF), Bay St. Louis, Mississippi, is evaluated as a potential location for safely testing and demonstrating equipment designed to control hazardous materials spills. The study includes an examination of all factors which influence the selection of an appropriate site with special emphasis on the assured protection of the environment. Within the identified constraints, three candidate areas were selected for more detailed investigation: the Northeastern Buffer Zone, the Southeastern Buffer Zone, and the North-Central Fee Area.

The report recommends the use of a 100-acre site located in the Northeastern Buffer Zone to conduct a three-phase development program. The program includes detailed initial and continuing environmental baseline monitoring, construction and operation of a semi-closed test facility, and continuing analysis and upgrading of program elements. The recommended test facility includes the following: an artificial stream channel, test ponds, landspill study areas, and supporting elements. The minimum estimated cost of initial monitoring, engineering and construction ranges from $604,000 to $675,000.

This report was prepared by Environment Control Corporation and submitted by the Hancock County Port and Harbor Commission, in fulfillment of the requirements of EPA Grant Number S-801830, under the sponsorship of the Environmental Protection Agency. Work was completed in February, 1974.

# CONTENTS

Page

Abstract . . . . . . . . . . . . . . . . . . . . . iv

List of Figures and Plates . . . . . . . . . . . . . vi

List of Tables . . . . . . . . . . . . . . . . . . xii

SECTIONS

1 Conclusions . . . . . . . . . . . . . . . . . . 1

2 Recommendations. . . . . . . . . . . . . . . . . 4

3 Introduction . . . . . . . . . . . . . . . . . . 5

4 Summary of Evaluation of Baseline Characteristics at the MTF . . . . . . . . . . . . . . . 9

5 Analysis of Test Elements Applicable to a Program of Testing/Demonstrating Equipment to Control Hazardous Materials Spills . . . . . . . . . . 15

6 Evaluation of Three Candidate Sites at the MTF . . 18

7 A Schematic Semi-Closed Test Facility Design . . . 45

8 Acknowledgements . . . . . . . . . . . . . . . . 54

9 References Cited . . . . . . . . . . . . . . . . 55

10 Selected Bibliography . . . . . . . . . . . . . . 61

APPENDICES

A Existing Facilities and Environmental Baseline Conditions . . . . . . . . . . . . . . . . 71

B MTF Tenant Agencies, Programs, Facility Usage and Potential Availability . . . . . . . . . . 236

C Evaluation of the Environmental Baseline Conditions, the Facilities, Structures and the Analysis of Three Candidate Sites for the Proposed Testing Center. . . . . . . . . . . . . . . . . . . 249

D Analysis of Open, Semi-Closed, and Closed Testing Elements for Testing/Demonstrating Equipment to Control Hazardous Materials Spills . . . . . . 294

E Persons Interviewed and Other Institutions Contacted for the MTF Evaluation and Systems Analyses . . 303

## LIST OF FIGURES AND PLATES

| Figure Number | | Page |
|---|---|---|
| 1 | Growth in Population and Chemical Production from 1958 to 1968 . . . . . . . . . . . . . . . . . . . . . | 6 |
| 2 | Schematic View of the MTF Buffer Zone and Fee Area Subdivided into Zones . . . . . . . . . . . . . . . | 10 |
| 3 | Location of Alternate Areas at the MTF . . . . . . . | 12 |
| 4 | Schematic Flow Chart of Relative Relationships of Degree of Hazard Versus Type of Test Element. . | 16 |
| 5 | Location of Three Candidate Sites at the MTF . . . . | 19 |
| 6 | Well and Soil Sample Locations in Site I, The Northeast Buffer Zone Site . . . . . . . . . . . . | 23 |
| 7 | Depth to Groundwater Map for Site I. . . . . . . . . | 24 |
| 8 | Well and Soil Sample Locations in Site II, The Southeast Buffer Zone Site . . . . . . . . . . . . | 26 |
| 9 | Depth to Groundwater Map for Site II . . . . . . . . | 27 |
| 10 | Well and Soil Sample Locations in Site III, The North Central Fee Site . . . . . . . . . . . . | 28 |
| 11 | Depth to Groundwater Map for Site III. . . . . . . . | 29 |
| 12 | Vegetative Sample Locations in Site I, The Northeast Buffer Zone Site . . . . . . . . . . . . | 32 |
| 13 | Vegetative Sample Locations in Site II, The Southeast Buffer Zone Site . . . . . . . . . . . . | 34 |
| 14 | Vegetative Sample Locations in Site III, The North Central Fee Site . . . . . . . . . . . . . . | 35 |
| 15 | Location of Three Candidate Sites and Potential Expansion Area . . . . . . . . . . . . . . . . . . . | 44 |
| 16 | Schematic Semi-Open Facility at Site I, The Northeast Buffer Zone Site . . . . . . . . . . . . | 46 |
| 17 | Schematic Cross Sections of Elements in Test Facility Design at Site I . . . . . . . . . . . . | 48 |

## LIST OF FIGURES & PLATES (Continued)

Figure Number — Page

18 Location of the MTF in the Southeastern United States . . . . . 73

19 Climatic Factors in the Southeastern United States . . . . . 75

20 The Mississippi Test Facility and Surrounding Region . . . . . 76

21 Transportation in the Vicinity of the MTF. . . . . . 78

22 The Mississippi Test Facility Fee Area and Buffer Zone . . . . . 79

23 Geologic Cross-Section of Mississippi. . . . . . . . 84

24 Quaternary Sediments in Southwest Mississippi. . . . 87

25 The MTF Soils Classification, Hancock County, Mississippi. . . . . 89

26 Soil Drainage Characteristics of the MTF . . . . . . 90

27 Physical Characteristics of Depositional Types, Mississippi River - Gulf Outlet Channel. . . . . . 96

28 The MTF Well Log Points . . . . . 100

29 Depth to Fresh/Saline Water Interface. . . . . . . . 119

30 Groundwater Levels -- Bay St. Louis and Waveland Areas, Hancock County, Mississippi . . . . . . . . 120

31 Location Map and Geohydrologic Sections, the Mississippi Test Facility, Hancock County, Mississippi. . . . . 121

32 Potentiometric Map of the MTF. . . . . . . . . . . . 123

33 Flow Chart of a Runoff Synthesis for the MTF, Pearl and Jourdan River Basins . . . . . . . . . . 124

34 The MTF Drainage Systems . . . . . 126

35a Pearl River Stage Gauge Discharge Rate, Jackson, Mississippi. . . . . 128

35b Pearl River Stage Gauge Discharge Rate, Bogalusa, Mississippi. . . . . 128

LIST OF FIGURES & PLATES (Continued)

Figure Number | Page

36 Known Hurricane Camille Influence on the Southwest Mississippi Coastal Region . . . . . . . . . 129

37 Schematic Map View of Coastal Environments in the Vicinity of the MTF . . . . . . . . . . . . . 132

38 Approximate Surface Saline/Brackish/Fresh Water Interface Observed in Southwest Mississippi . . . 133

39 Regional Climatic System--Southeastern United States. . . . . . . . . . . . . . . . . . . . . . 138

40 Percent of Monthly Daytime Periods (0700-1800 CST) Calm Wind Conditions Occur at Indicated Heights . 143

41 Percent of Monthly Night-time Periods (1900-0600 CST) Calm Wind Conditions Occur at Indicated Heights . . . . . . . . . . . . . . . . . . . . . . 144

42 Percent of Total Calm Conditions Per Month at Indicated Heights at the MTF. . . . . . . . . . . 145

43 Percent of Time, Temperature Differences ($\Delta T$) Occur for 0.40°C Ranges as Obtained from the MTF Temperature Profile Data. . . . . . . . . . . 146

44 Annual Wind Rose. . . . . . . . . . . . . . . . . . 151

45 The MTF Average Annual Wind Rose. . . . . . . . . . 152

46a Probability of Sound Focusing by Azimuth at the MTF . . . . . . . . . . . . . . . . . . . . . . . 157

46b Polar Distribution of Average Sound Attenuation at the MTF. . . . . . . . . . . . . . . . . . . . . 157

47 Overall Sound Pressure Level Contours--Single Engine Static Firing at the MTF . . . . . . . . . 159

48 Floristic Provinces of the Southeastern United States. . . . . . . . . . . . . . . . . . . . . . 161

49 Regional Distribution of Four Important Species of Pine in the Southeastern United States . . . . 168

50 Regional Distribution of Four Species of Oak in the Southeastern United States. . . . . . . . . . 169

LIST OF FIGURES & PLATES (Continued)

Figure Number | | Page
51 Buildings and Structures in the MTF Southern Fee Area . . . . . . . . . . . . . . . . . . . . . 183

52 Location of Utilities Systems in the MTF Southern Fee Area -- Potable Water Lines. . . . . . . . . . 189

53 Location of Utilities Systems in the MTF Southern Fee Area -- High Pressure Industrial Water Lines. . . . . . . . . . . . . . . . . . . . . 191

54 Location of Utilities Systems in the MTF Southern Fee Area -- Sanitary Sewerage System . . . . . . 193

55 Location of Utilities Systems in the MTF Southern Fee Area -- High Temperature Hot Water/Chilled Water Systems. . . . . . . . . . . . . . . . . . 195

56 Location of Utilities Systems in the MTF Southern Fee Area -- Electrical Distribution System . . . 197

57 Location of Utilities Systems in the MTF Southern Fee Area -- Natural Gas Lines. . . . . . . . . . 199

58 Location of Utilities Systems in the MTF Southern Fee Area -- High Pressure Air Lines. . . . . . . 201

59 Location of Utilities Systems in the MTF Southern Fee Area -- Hydrogen System. . . . . . . . . . . 203

60 Location of Utilities Systems in the MTF Southern Fee Area -- Helium System . . . . . . . . . . . . 205

61 Location of Utilities Systems in the MTF Southern Fee Area -- Liquid Oxygen. . . . . . . . . . . . 207

62 Location of Utilities Systems in the MTF Southern Fee Area -- Nitrogen System. . . . . . . . . . . 209

63 Location of Utilities Systems in the MTF Southern Fee Area -- Rocket Propellant-1. . . . . . . . . 211

64 Gulf Coast Hydroscience Center -- Flood Plain Simulation Facility. . . . . . . . . . . . . . . . 240

65 Gulf Coast Hydroscience Center, Hydroscience Laboratory Facility. . . . . . . . . . . . . . . . 242

66 Schematic View of the MTF Buffer Zone and Fee Area Subdivided into Zones . . . . . . . . . . . 254

LIST OF FIGURES & PLATES (Continued)

| Figure Number | | Page |
|---|---|---|
| 67 | Grain Size Distribution Diagram for Soil Sample 1-1 . . . . . . . . . . . . . . . . . . . . | 268 |
| 68 | Grain Size Distribution Diagram for Soil Sample 1-3 . . . . . . . . . . . . . . . . . . . . | 269 |
| 69 | Grain Size Distribution Diagram for Soil Sample 1-4 . . . . . . . . . . . . . . . . . . . . | 270 |
| 70 | Grain Size Distribution Diagram for Soil Sample 1-5 . . . . . . . . . . . . . . . . . . . . | 271 |
| 71 | Grain Size Distribution Diagram for Soil Sample 2-1 . . . . . . . . . . . . . . . . . . . . | 272 |
| 72 | Grain Size Distribution Diagram for Soil Sample 2-2 . . . . . . . . . . . . . . . . . . . . | 273 |
| 73 | Grain Size Distribution Diagram for Soil Sample 2-3 . . . . . . . . . . . . . . . . . . . . | 274 |
| 74 | Grain Size Distribution Diagram for Soil Sample 2-4 . . . . . . . . . . . . . . . . . . . . | 275 |
| 75 | Grain Size Distribution Diagram for Soil Sample 2-5 . . . . . . . . . . . . . . . . . . . . | 276 |
| 76 | Grain Size Distribution Diagram for Soil Sample 3-1 . . . . . . . . . . . . . . . . . . . . | 277 |
| 77 | Grain Size Distribution Diagram for Soil Sample 3-2 . . . . . . . . . . . . . . . . . . . . | 278 |
| 78 | Grain Size Distribution Diagram for Soil Sample 3-3 . . . . . . . . . . . . . . . . . . . . | 279 |
| 79 | Grain Size Distribution Diagram for Soil Sample 3-4 . . . . . . . . . . . . . . . . . . . . | 280 |

**PLATES**

| | | |
|---|---|---|
| 1 | Site I, View of Burned and Harvested Area North of Access Road . . . . . . . . . . . . . . . . . | 38 |
| 2 | Site I, View of Northeast Periphery of Burned Area . . . . . . . . . . . . . . . . . . . . . | 38 |
| 3 | Site I, View of Northwest Periphery of Burned Area . . . . . . . . . . . . . . . . . . . . . | 38 |

Plates (Continued)

Page

4 Site I, Fire-Break Around the Remaining Trees in Center of Burned Area . . . . . . . . . . . . . . . 38

5 Site I, Old Field Area in Southeast of Site . . . . 39

6 Site I, Old Field Area in Southwest of Site . . . . 39

7 Site II, View Northward Along Access Road . . . . . 39

8 Site II, View of Open Field to West of Access Road. . . . . . . . . . . . . . . . . . . . . . . . 39

9 Site II, Slash Pine Plantation to the East of the Access Road . . . . . . . . . . . . . . . . . . 40

10 Site II, View of Topographically High Area. . . . . 40

11 Site II, View of Northern Periphery of Site . . . . 40

12 Site II, View of Southern Edge of Site. . . . . . . 40

13 Site III, View of Side Road Northward from East-West Access Road . . . . . . . . . . . . . . . 41

14 Site III, View of Slash Pine and Mixed Shrubs from Southeast Corner of Site . . . . . . . . . . 41

15 Site III, View of Slash Pine Plantation in Center of Site . . . . . . . . . . . . . . . . . . 41

# LIST OF TABLES

| Table Number | | Page |
|---|---|---|
| 1 | Polluting Spills in U.S. Waters During the Year 1971 . . . . . . . . . . . . . . . . . . | 7 |
| 2 | Percent Change in Population in Selected Cities, 1960 to 1970 . . . . . . . . . . . . . . | 81 |
| 3 | Geologic Column for the State of Mississippi. . . . | 83 |
| 4 | MTF Well Log Description (Well Points Located on Figure 12). . . . . . . . . . . . . . . . . . | 101 |
| 5 | MTF Logs of Borings (Located on Figure 12). . . . . | 104 |
| 6 | MTF Potable and Industrial Geochemical Data (Well Points Located on Figure 12). . . . . . . . | 116 |
| 7 | Records of Mississippi Test Facility Water Wells. . | 118 |
| 8 | Water Quality of the Pearl River Near Columbia, Mississippi During the Water Year November 1969 to September 1970. . . . . . . . . . . . . . | 135 |
| 9 | Mississippi Sound Sediment Geochemical Data . . . . | 136 |
| 10 | Summary of Monthly (1892-1970) Precipitation Data, Hancock County, Mississippi . . . . . . . . | 140 |
| 11 | Summary of Monthly (1900-1970) Temperature Data, Hancock County, Mississippi . . . . . . . . . . . | 141 |
| 12 | Statistics of Yearly Wind Profile Data as Observed at the Mississippi Test Facility (MTF) Weather Station, Bay St. Louis, Mississippi, October 1, 1963-September 30, 1964 (Anemometer Level: 2.0 meters) . . . . . . . . . . . . . . . . . . . | 147 |
| 13 | Statistics of Yearly Wind Profile Data as Observed at the Mississippi Test Facility (MTF) Weather Station, Bay St. Louis, Mississippi, October 1, 1963-September 30, 1964 (Anemometer Level: 4.0 meters) . . . . . . . . . . . . . . . . . . . | 148 |
| 14 | Statistics of Yearly Wind Profile Data as Observed at the Mississippi Test Facility (MTF) Weather Station, Bay St. Louis, Mississippi, October 1, 1963-September 30, 1964 (Anemometer Level: 8.0 meters) . . . . . . . . . . . . . . . . . . . | 149 |

TABLES (Continued)

| Table Number | | Page |
|---|---|---|
| 15 | Statistics of Yearly Wind Profile Data as Observed at the Mississippi Test Facility (MTF) Weather Station, Bay St. Louis, Mississippi, October 1, 1963-September 30, 1964 (Anemometer Level: 16.0 meters). . . . . . . . . . . . . . . . . . . . | 150 |
| 16 | Noise Level and Relative Loudness of Typical Noises in Indoor and Outdoor Environments. . . . . . . . | 155 |
| 17 | Scientific Names of Plant Species Used in Text of Terrestrial and Aquatic Biota in the MTF Area. . . . . . . . . . . . . . . . . . . . | 163 |
| 18 | Selected Vascular Species Identified in Davis Bayou and on Ship Island, Mississippi (1970). . . | 170 |
| 19 | MTF -- Buildings and Structures . . . . . . . . . . | 179 |
| 20 | MTF -- Quantity-Distance Requirements . . . . . . . | 228 |
| 21 | Evaluation of Local/Regional Parameters Important in the Selection of the MTF as a HMSE Test Center. . . . . . . . . . . . . . . . . . . . | 251 |
| 22 | Evaluation of Baseline Parameters at the MTF in Relation to HMSE Testing. . . . . . . . . . . . | 259 |
| 23 | Depth to Groundwater Data for Sites I, II and III . . . . . . . . . . . . . . . . . . . . . . | 267 |
| 24 | Plant Species Collected at Sites I, II, and III Mississippi Test Facility, Bay St. Louis, Mississippi . . . . . . . . . . . . . . . . . . | 282 |
| 25 | Ten Factor Prism Determinations of Three Woody Communities Using the Modified Bitterlich-Grosenbaugh Technique . . . . . . . . . . . . . . | 288 |
| 26 | Tree Cores (annual increment cores) Record for the Three Candidate Sites at the MTF. . . . . . . | 290 |
| 27 | Representative Ages and dbh's at Selected Locations at the Three Candidate Sites at the MTF . . . . . | 292 |
| 28 | General Evaluation of Open, Semi-Closed, and Closed Testing at the MTF . . . . . . . . . . . . | 297 |

# SECTION 1

# CONCLUSIONS

1. A facility for the testing and evaluation of equipment and related operating procedures to contain and cleanup accidental spills of hazardous materials is an essential element of the EPA Hazardous Materials Program. Such a facility is referred to herein as a Hazardous Materials Spills Equipment Test and Demonstration (HMSE) Facility.

2. The HMSE Facility should consist of an artificial stream channel, test ponds, a landspill area and the necessary support facilities to operate these units and to completely evaluate the performance of equipment and procedures to be tested.

3. The HMSE Facility must be constructed and operated in a manner which does not produce adverse environmental effects while duplicating, to the extent possible, natural conditions which are anticipated to be encountered in an actual hazardous material spill. The facilities which best satisfy these conditions must be artificially constructed and they must assure the containment of any of the test materials introduced for the purpose of equipment and procedure evaluation. At the same time, they must operate in the open environment as much as possible. Such facilities are described herein and referred to as "semi-closed" facilities.

4. Three specific geographic locations on the Mississippi Test Facility (MTF) property have been investigated in detail and reported herein. Each of these three sites is suitable for the location of the recommended HMSE Facility. Other locations on the MTF property may also be suitable. Hazardous materials spills control equipment test programs can be conducted on these sites in a manner which will not produce adverse environmental effects.

5. Certain areas of the MTF should be excluded from consideration as a site location for the HMSE Facility. This is due to potentially adverse environmental effects of program operation or conflict with on-going programs at the MTF. The major constraints are as follows:

   a. Flood plains of major streams and tributaries, e.g., the Pearl River, should be avoided and considered as high-risk areas in terms of floods and flood-related damages.

b. The National Aeronautics and Space Administration (NASA) canal system, although available for transportation purposes, should be considered unavailable for testing both because of the high degree of public view and because of the projected heavy demand use by NASA in future tests of Space-Shuttle engines.

c. NASA test stands and support facilities, other than utilities and services, are being upgraded for Space-Shuttle tests and should be considered as generally unavailable for use.

d. Low-lying areas flooded by Hurricane Camille in 1969 should also be avoided.

e. Main-stem stretches of the Pearl, the Jourdan, and the Bayou La Croix should not be used for testing, unless the controllability of testing can be guaranteed to conserve water quality and quantity.

6. Some elements of on-going programs at the MTF are supportive to and would be compatible with a HMSE Facility.

The U.S. Geological Survey (USGS) facilities in the Central Fee Area are indicated as available for limited testing, this depending on controllability of the test as well as degree of availability of the facilities. The USGS facilities could be used as a support unit for tests based at one of the three candidate sites.

The technical and analytical support services available at the MTF would be well-suited for an equipment testing program. These include the hardware and software computer facilities, the laboratory analytical services already available to do pesticide analyses, the water quantity and quality expertise of the USGS, the existing capabilities on the site for disposal of hazardous materials, including the U.S. Army and NASA personnel, and the capabilities for the handling and transporting of cryogenic materials. Use of these support services would have to be coordinated with existing and future NASA space-related activities, especially those located near test pads or those directly involved in the testing of space vehicles.

7. Weather patterns and unusual meteorological events experienced on the southern Mississippi Gulf Coast are not incompatible with the initiation and operation of the proposed HMSE Facility at the MTF. The worst hurricane event recorded in history, Hurricane Camille, in August, 1969, caused no permanent or significant damage to the buildings, structures, and facilities at the MTF site. Although tornadoes, heavy rainfalls, and

severe electrical storms are more probable than in some other parts of the United States, structural and operational precautions are feasible in terms of controls for testing of equipment. The mild winters and warm summers, the large number of sunny and partly-sunny days per year, and the evenly distributed annual precipitation enhance the area's attributes. The lack of some weather extremes is beneficial from the standpoint of implementing the test program; however, this characteristic may be limiting in terms of necessary test information related to the effects of extreme cold, snows, ice storms, or arid conditions.

8. In respect to nationwide access, the MTF is conveniently located to serve as a potential site for the testing and demonstration of equipment to control hazardous materials spills. Additionally, the MTF site is located within the fastest developing economic region in the country, an area which has much of the petroleum and petrochemical industry of the nation. The proposed test center therefore would be located near numerous potentially hazardous spills conditions within the region.

9. Project costs up to the point of operation of the HMSE Facility are estimated to be \$604,000 to \$675,000 depending on the site selected and the final design sizing of program elements. Of the three geographic locations investigated, the 100-acre site in the Northeastern Buffer Zone has several advantages over the other two sites. Besides being less expensive in terms of initial development and operation, the northeastern site has the potential to be most easily expanded beyond the 100-acre limits. While being well-buffered from public view, the site is easily reached from the Central Fee Area on existing roads. Electrical utilities are present in the area and water wells in the area indicate good quality and good yields. The topography is varied; the site possesses both wooded and clear areas; and soils, surface water, and groundwater conditions meet controllability criteria.

## SECTION 2

## RECOMMENDATIONS

1. Based on the information developed in this project, the Mississippi Test Facility (MTF) should be evaluated against other candidate locations in the nation and a determination should be made as to whether the MTF site will best meet the national needs as regards the location of a Hazardous Materials Spills Equipment Test and Demonstration (HMSE) Facility.

2. If the MTF is selected as a suitable site for a HMSE Facility, the 100-acre site in the Northeastern Buffer Zone of the MTF, which was studied in detail in this project, is recommended as the specific location for the HMSE Facility.

3. Negotiations should be undertaken with the National Aeronautics and Space Administration (NASA) to provide for EPA to become a tenant at the MTF with a HMSE Facility.

4. A three-phase development program is recommended to be initiated as follows:

    a. Initial and continuing environmental monitoring/surveillance should be begun to quantify the environmental baseline conditions and responses to a testing program at the recommended location at the 100-acre Northeastern Buffer Zone site.

    b. The design, construction, and operation of the proposed semi-closed testing elements should be begun concurrently with the environmental monitoring/surveillance program.

    c. An examination of the need for the future development of open and/or closed testing elements should be investigated. Included in this investigation would be the analysis of needs for future site expansion and the role of the U.S. Geological Survey (USGS) facilities as supportive to the program effort.

5. The necessary budget should be provided to carry out the development program with cost estimated to be $604,000 to $675,000 for facility development.

# SECTION 3

# INTRODUCTION

American industry, the major producer of hazardous materials, handles these materials at virtually every industrial location throughout the country and regularly transports them by various modes such as truck, barge, ship, train, pipeline and aircraft. Figure 1 illustrates the increase in production of chemicals in the United States during the ten-year period between 1958 and 1968 (McConnaughey, 1970). During that period, production of organic and inorganic chemicals, respectively, increased 130 percent and 90 percent. In comparison, during the 1958-1968 period, the rate of increase in population growth was a relatively small 15 percent.

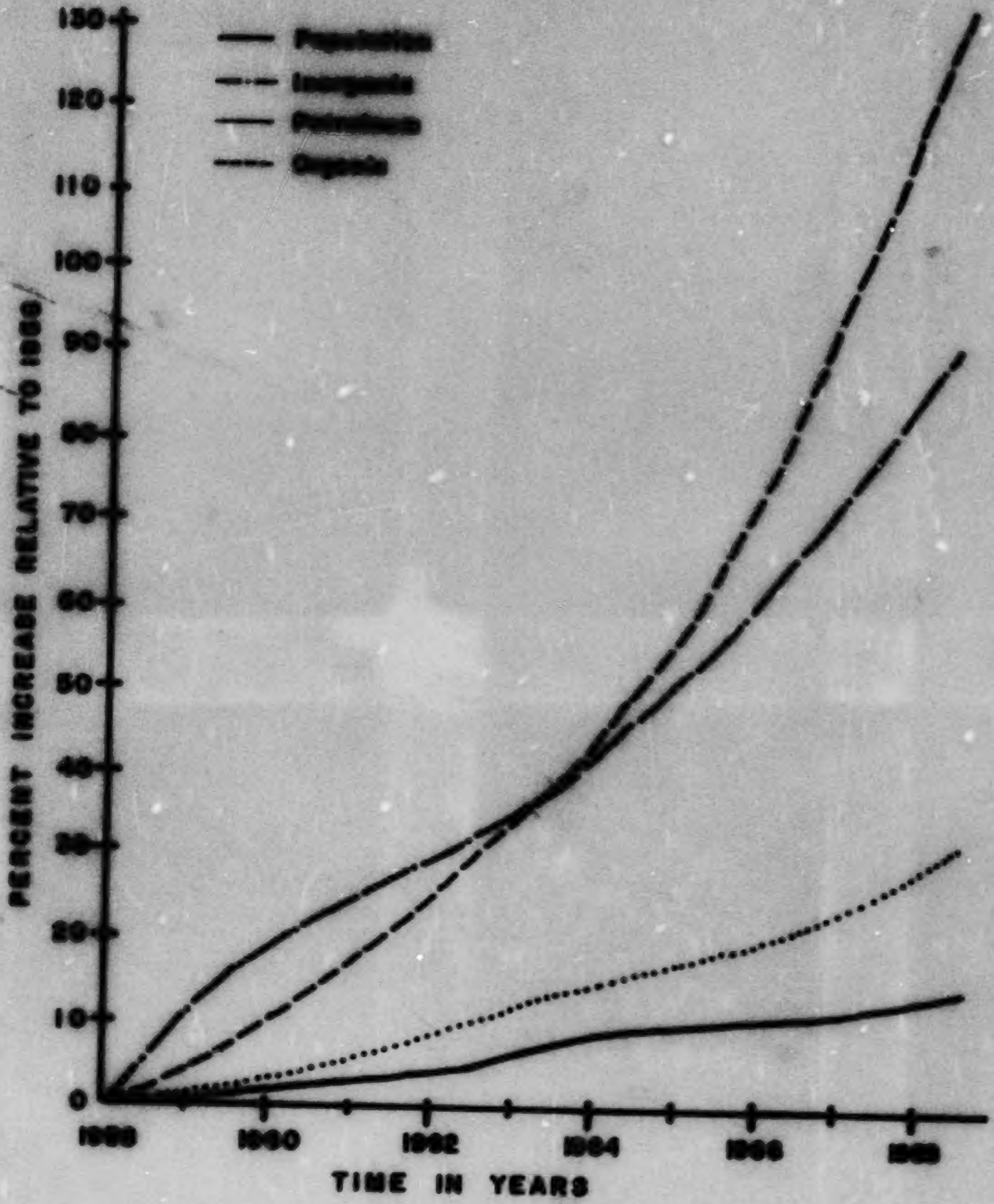
The increased production and transport of chemicals have, in turn, increased the incidence rate of accidental spills in the United States. In 1971, the U.S. Coast Guard received reports of 8,496 spills, as compared to 3,711 reports in 1970 (U.S. Coast Guard, 1971). This represents approximately a 229 percent increase in incidence of spills in that one-year period; however, a large part of the increase was due to improved reporting requirements. Table 1 presents detailed data from the U.S. Coast Guard for water-related spills during 1971.

In addition to the U.S. Coast Guard data, the U.S. Department of Transportation (USDOT) reported 12,664 landspills associated with overland shipments of various hazardous materials between January 1, 1971 and December 31, 1973 (USDOT, 1974).

Although the USDOT figures do not include pipeline transport or storage container data, the 12,664 land-related spills indicate: (1) a large and significant number of non-water related spills, and (2) the probability of a greater number of spills (which are not reported under present reporting techniques). The breakdown of the USDOT data by year is as follows:

| Year | Number of Reported Spills |
|---|---|
| 1971 | 2,256 |
| 1972 | 4,347 |
| 1973 | 6,061 |
| Total (1971-1973) | 12,664 |

The USDOT figures also indicate a progressive increase in the number of accidental spills reported over the three-year period of operation by the Office of Hazardous Materials of the Accident Analysis Office. The number of reports for 1973 represents an increase of 37 percent over the reports of 1971 and represents 48 percent of all known reports since the USDOT Accidental Spills Reporting Program began in 1971.



GROWTH IN POPULATION AND CHEMICAL PRODUCTION FROM 1958 TO 1968

Figure I

Modified From: McConnaughey, et al 1970

## TABLE 1

## POLLUTING SPILLS IN U.S. WATERS DURING THE YEAR 1971 (U.S. COAST GUARD, 1971)

|  | DESCRIPTION OF REPORTED SPILLS | NUMBER | VOLUME** |
|---|---|---|---|
| Cause | Casualty (includes collision, grounding, and blowouts) | 205 | 3046 |
|  | Rupture, leak or structural failure | 2754 | 3716 |
|  | Equipment failure (valves, pumps, alarms) | 941 | 378 |
|  | Personnel failure | 827 | 1037 |
|  | Deliberate discharges | 359 | 75 |
|  | Natural phenomena | 102 | 8 |
|  | Unknown | 3308 | 729 |
|  | TOTAL | (8496) | (8989) |
| Source | Vessel | 2086 | 4012 |
|  | Tanker | 380 | 1666 |
|  | Tank barge | 816 | 1304 |
|  | Other | 890 | 1042 |
|  | Transportation related facility | 1932 | 1429 |
|  | Marine facility | 390 | 256 |
|  | Vehicle | 74 | 101 |
|  | Pipeline | 1446 | 912 |
|  | Other | 22 | 160 |
|  | Non-transportation related facility | 2022 | 3208 |
|  | Onshore and offshore production | 1123 | 122 |
|  | Onshore bulk storage (includes tank farms) | 295 | 447 |
|  | Refinery | 187 | 2207 |
|  | Other | 417 | 432 |
|  | Miscellaneous and unknown | 2456 | 356 |
|  | TOTAL | (8496) | (9005) |
| Type of Pollutant | Light oil (light crudes, gasoline, benzene, etc.) | 4303 | 2932 |
|  | Heavy oil (kerosene, diesel oil, fuel oil, residues, heavy crudes) | 1569 | 2987 |
|  | Waste and other oil | 1574 | 2878 |
|  | Other substances (hazardous commodities, chemicals, gases, etc.) | 172 | 112 |
|  | Miscellaneous (sewage, refuse, dredge spoil and unknown) | 878 | 194 |
|  | TOTAL | (8496) | (9103) |
| Location | Internal waters (harbors, rivers, bays, etc.) | 7227 | 5653 |
|  | Great Lakes | 377 | 2594 |
|  | Marine (territorial, contiguous and high seas beyond) | 892 | 709 |
|  | TOTAL | (8496) | (8956) |
|  | OVERALL TOTAL | 8496 | 8991 |

**Volume expressed in thousands of gallons ($10^3$); totals do not sum due to rounding and other inconsistencies. (2.45% deviation at maximum).

A measure of the significance of spills of hazardous materials and the growing public concern can be found in the Water Quality Improvement Act of 1970, the Federal Water Pollution Control Act of 1972, and the Toxic Substances Bill of 1972, which altogether set forth regulations relating to the discharge and dispersion of hazardous substances in the environment. Responding to recent legislation and the fact that accidental spills frequently result in significant environmental problems, EPA has initiated the development of programs relating to hazardous materials spills handling and dispersion control technology, collection and detoxification equipment, and spill response techniques. Much of the test equipment that has been and is currently being developed remains untested under full-scale operating conditions. Of primary importance is the establishment of a standardized testing program, where equipment and processes can be comparatively evaluated in terms of their effectiveness and practicability under "real-life" conditions.

Due to the nature and large array of hazardous materials and the problems associated with handling these materials even under test situations, a great degree of safety and test control reliability is essential for a full-scale testing facility. Currently, no naturally existing full-scale open system site is capable of providing sufficient safety against unwanted hazardous materials dispersion. The need for large-scale, partially or completely controlled test conditions, therefore, assumes a high priority in the development of a functioning hazardous materials testing program.

Therefore, evaluation of the MTF as a potential location for the testing/demonstration of equipment to control hazardous materials spills involved the following principal objectives: (1) definition of the feasibility of the MTF as a location for a testing program; (2) definition of the constraints as well as the positive aspects of a site, and at minimum two alternates, at the MTF; and (3) definition of what can and must be done to best utilize the site without impinging on the aspect of universal usability of the MTF.

# SECTION 4

## SUMMARY OF EVALUATION OF BASELINE CHARACTERISTICS AT THE MISSISSIPPI TEST FACILITY

### LOCATION

The Mississippi Test Facility (MTF) is located in Bay St. Louis, Mississippi, and encompasses 141,960 acres of land and water area: 13,434 acres in the government-owned Central Fee Area, and 128,526 acres in the government-owned or leased acoustical Buffer Area. The MTF is located 7 miles northwest of the intersection of Interstates 10, 59 and 12 and can be easily reached by freeways in 20-30 minutes from downtown New Orleans. Other regional and subregional data and information are presented in more detail in Appendix A (see pp. 71 to 80).

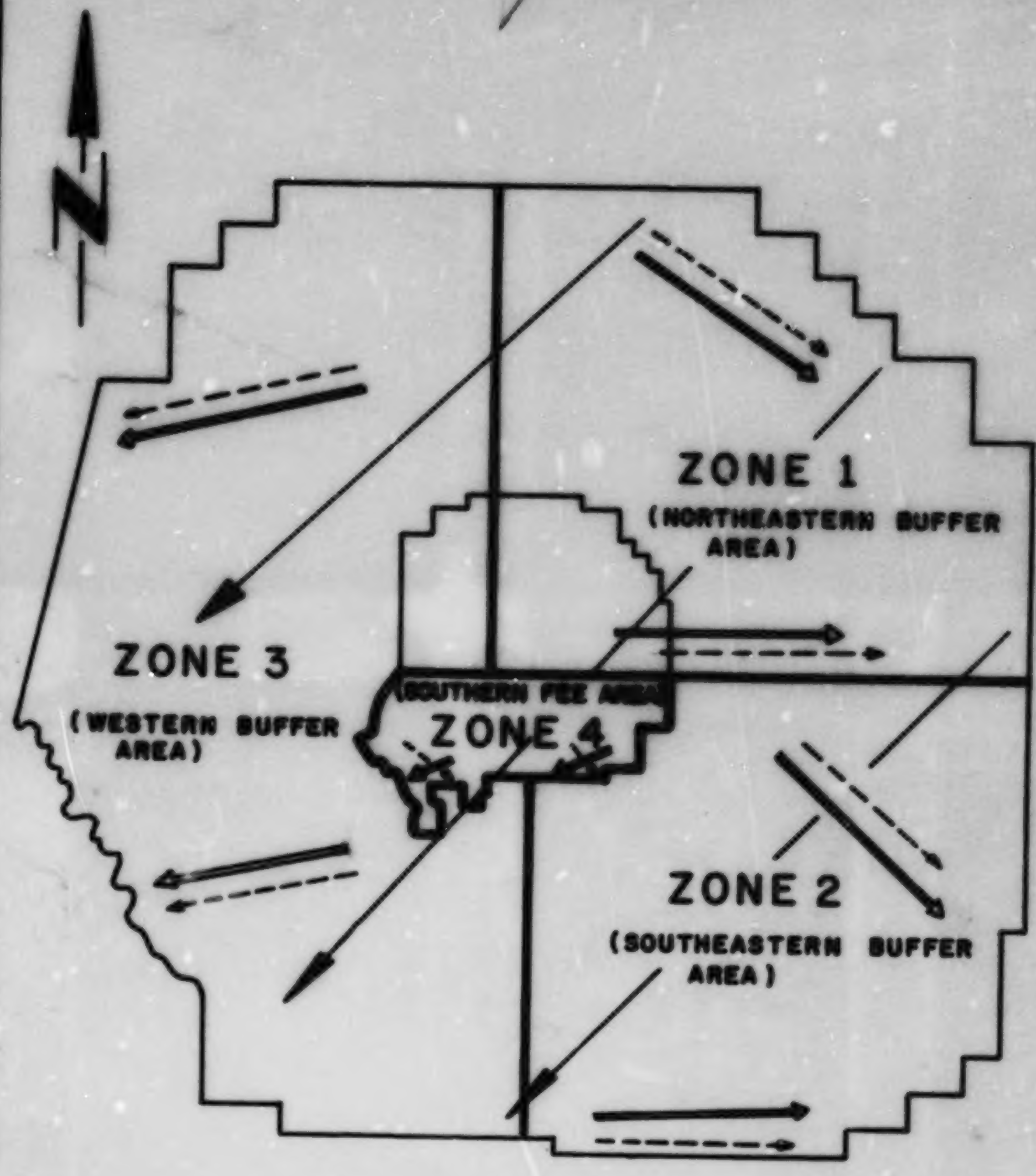
### STUDY METHODS AND BASELINE CONDITIONS INVESTIGATED

In considering the MTF as a location for the development of a facility to test/demonstrate equipment for control of hazardous materials spills, certain environmental and physical plant baseline conditions were defined, analyzed, and evaluated. A survey of all available data, on-site and off-site interviews of persons having useful knowledge or local expertise in scientific and related fields (see Appendix E for List of Interviews), and on-site field observations and measurements were used in the information gathering process. The information obtained by these methods is analyzed, interpreted, and synthesized in text form in Appendix A (pp. 71 to 235). The categorical descriptions for each of these baseline items include detailed descriptions of:

- Baseline Aspects: Region and Area (pp. 71 to 79).
- Geological Aspects of the Southwestern Mississippi Area (pp. 80 to 85).
- Soils and Sediments of Southwestern Mississippi and the MTF Area (pp. 86 to 96).
- Hydrologic Aspects of Southwestern Mississippi and the MTF Area (pp. 97 to 133).
- Climatic and Meteorological Aspects of Southwestern Mississippi and the MTF Area (pp. 134 to 160).
- Terrestrial and Aquatic Biota in the MTF Area (pp. 161 to 177).
- MTF Facilities and Structures (pp. 178 to 188).
- MTF Utilities and Services (pp. 188 to 235).

### EVALUATIONS OF BASELINE CONDITIONS: ZONES

The information in the above units was then evaluated for each of four zones at the MTF (see Appendix C, pp. 249 to 293). Figure 2 illustrates the four zones used for the general site evaluation (zonation based on different surface drainage systems: Zone 1, the Jourdan River; Zone 2, the Bayou La Croix; Zone 3, the Pearl River; and Zone 4, surface runoff to the Pearl River and immediate subsurface drainage in the Bayou La Croix). In each zone, 61 baseline parameters were evaluated on a basis of (1) degree of present definition



SCHEMATIC VIEW OF THE MTF BUFFER ZONE & FEE AREA SUBDIVIDED INTO ZONES

⇒ DIRECTION OF SURFACE FLOW

- - -→ DIRECTION OF SUBSURFACE FLOW (SHALLOW GROUNDWATER)

→ DIRECTION OF DEEP GROUNDWATER FLOW

Figure 2

of the parameter, and (2) degree of adaptability in relation to a test program for hazardous materials spills equipment (HMSE) test program (see pp. 249 to 293). In order of importance, considerations in the multiparameter evaluation of the four zones included the following:

- * Favorable or unfavorable groundwater conditions.
- * Controllable or uncontrollable surface drainage conditions.
- * Proximity to flooding.
- * Soils characteristics.
- * Favorable or unfavorable biotic conditions.
- * Availability based on known land use patterns or potential program conflicts.
- * Ability for site expansion; i.e., beyond the proposed 100-acre boundary lines.

Other factors were found to be important; however, these were determined to be equally important in all four zones of the MTF:

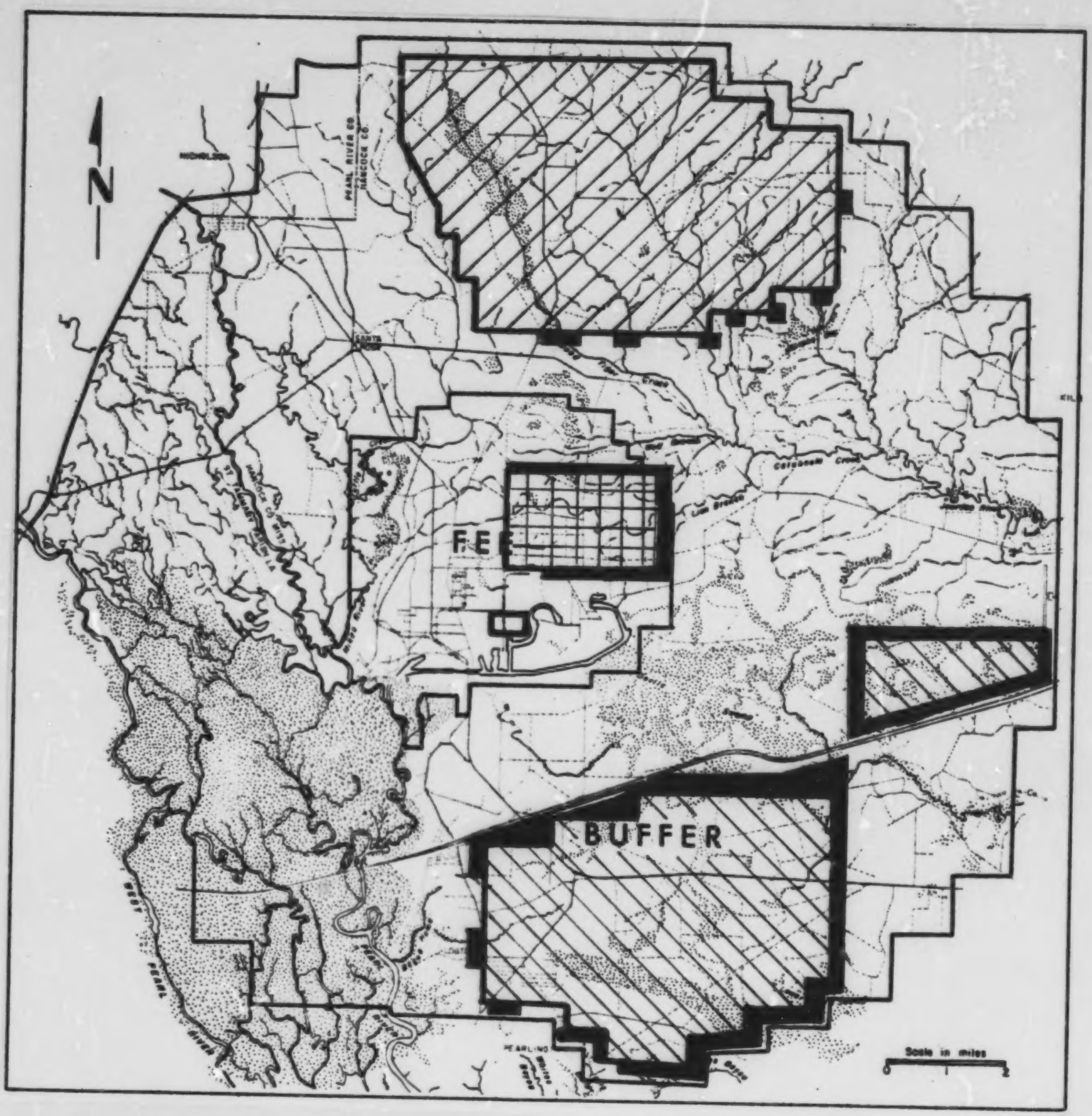
- * Site meteorology and climatology
- * Site geology.
- * Site regional/local characteristics and degree of public acceptance.

## RESULTS OF BASELINE EVALUATIONS: A BRIEF SUMMARY

The results of the multiparameter evaluations of the baseline conditions and parameters of relative site availability indicated Zone 1 (the Northeastern Buffer Zone Area) to be the most suitable of the four zones for the development of an HMSE test program. Other considerations included the Southeastern Buffer Zone Area, the North-Central Fee Area, and the USGS Hydroscience-Floodplain Facilities in the Central Fee Area as candidate sites. Figure 3 shows the location of these areas. Briefly summarizing important considerations affecting the relative evaluation of the candidate areas, the following summary is given (refer to pp. 249 to 293 for further detail):

1. In Zones 1 and 2, groundwater resources are controllable (upward gradient) and plentiful (high hydrostatic head with varied yields, quality and temperatures). Shallow groundwater layers in the USGS Hydroscience Area are thought to flow toward the Bayou La Croix; controllability is possible with adequate definition of characteristics and provisions for control.

2. Surface water quality in Zones 1, 2 and 4 is generally good, and surface flows are capable of regulation in terms of direction and rate of flow; however, diking is advisable to prevent flood-associated problems in the Southeastern Buffer Zone Area. The Northeastern Buffer Zone Area, the North-Central Fee Area, and the USGS facilities, although subject to occasional heavy-rainfall/high runoff rates, are not subject to significant flood-associated damages.



FEE—Central fee area of the MTF
BUFFER—Buffer zone that surrounds the central fee area

▨ NORTHEASTERN BUFFER AREA (ZONE 1)

▧ SOUTHEASTERN BUFFER AREA (ZONE 2)

⊞ NORTH-CENTRAL FEE AREA GENERAL LOCATION (ZONE 1)

☐ USGS HYDROSCIENCE-FLOOD PLAIN FACILITY (ZONE 4)

■ SURFACE DRAINAGE AREAS NEEDING MONITORING AND/OR TREATMENT IF CONTAMINATED

LOCATION OF ALTERNATE AREAS AT THE MTF

Figure 3

3. In terms of terrain, soils characteristics, and biota in each of the areas, Zone 1 (the northeastern area) provides a wide variety of topographic highs and lows, soil types, and an average representation of Southwest Mississippi flora and fauna. Zone 2 offers less varied topographic features and soil types, and many areas are known to be inhabited by rarely encountered and/or endangered reptiles; e.g., various snakes and the American alligator. The USGS facilities are constructed on filled-in materials which are compatible with an HMSE Facility, and biota are limited to aquatic forms which inhabit the Canal System (e.g., alligator gar) and domesticated and remnant stands of terrestrial flora. The North-Central Fee Area is represented by moderately to poorly drained soils, moderate topographic variation, and a variety of wooded and cleared areas. All areas have characteristically high vegetative recovery rates; thus control of exposed soils and of subsequent erosion can be readily accomplished.

4. Availability of all areas is conditional to future land use determinations. The Northeastern Buffer Zone and the North-Central Fee Area (in part or all) may be utilized by NASA or another government agency in the future, the nature of use and the extent or probability of which remain unknown at the present time. The Southeastern area is presently available, and the USGS facilities are available subject to use by the USGS and other tenant agencies, as well as subject to evacuation during NASA engine test firings on nearby test stands. Site expansion is possible in both Areas 1 and 2, but limited both in the USGS area (canals, roadways, and existing land use and program buffer areas limit this site) and in the North-Central Fee Area (the Pearl drainage to the west, main-stem Jourdan tributaries to the north and east, and existing Fee Area developments to the south).

## SUMMARY OF MOST IMPORTANT ELEMENTS OF GENERAL BASELINE SURVEY

The evaluation of baseline characteristics at the MTF, as summarized in this section, provided the basis for (1) a determination of the overall feasibility of the location of an HMSE facility at the MTF, (2) a determination of the relative importance of various environmental parameters in relation to an HMSE facility at the MTF, and (3) a determination of the best potential areas to be considered for a specific location within the boundary lines of the MTF. In terms of overall feasibility, the MTF provides good to excellent utilities, services, supportive facilities, and transportation. The regional/local attributes are highly favorable, and the general environmental quality is conducive to development of an efficiently designed and well-controlled HMSE facility.

In terms of environmental parameters important to the development of an HMSE facility, relative importance is determined based on: (1) preservation of existing natural resources, (2) an evaluation of natural resources most imporant to the maintenance of ecologic balance in the area, and (3) the maintenance of human activities in the area. Clearly, the most important parameters include surface and groundwater quality and quantity, air quality, and preservation of significant rare and/or endangered populations of plants and animals. These factors are evaluated with considerations for maintenance of land values, i.e., important forest resources, as well as aesthetics and other human needs. In these considerations, certain elements become generally important; these are listed below:

1. All floodplain areas and main-stem stretches of the Pearl, the Jourdan and the Bayou La Croix (and major tributaries) should not be developed because these areas are (a) high-risk in terms of flooding, (b) unsuitable in terms of control of tests and/or accidental spills, and (c) biotically productive and recreational in terms of present uses.

2. Adequate provisions should be made to ensure good quality water (ground and surface); therefore, treatment facilities should be designed to purify all HMSE discharges, and ambient surface and groundwater flows should be controlled to prevent significant contamination, i.e., major aquifer recharge zones such as the Pearl River floodplain, should not be developed.

3. In the event of an accidental release of a hazardous material, adequate controls (definition and preventative measures) should be devised to minimize contamination of significant surface and groundwater systems, soils formations, vegetation, and air.

4. Although the climatological and meteorological aspects of the area present few problems in terms of rate of incidence of catastrophic events, adequate provisions for hurricane, tornado, severe electrical storm, heavy rainfall, and rapid runoff are presently possible, and should be considered in any program design at the MTF.

5. Areas inhabited by rare and/or endangered species, e.g., the American alligator, or by highly seclusive species of birds or other wildlife should be conserved in the natural state. Areas considered for the development of an HMSE facility should be designed to minimize the impact on the ecologic balance that supports these and other locally important species.

6. Surveillance and monitoring, in addition to proper design and control of tests and facilities, is suggested. Detection of changes in the local environment as a result of activities at an HMSE facility would benefit corrective measures to protect human life as well as the local environmental resources.

Based on these aspects, as well as existing and projected MTF tenant agencies' land uses, the candidate areas in Zones 1, 2, and 4 were selected as (a) adequate to meet the needs for the design of an HMSE facility, and (b) adequate in terms of environmental control and preservation. Section 5 presents specific sites and detailed feasibility analyses of the specific sites selected from the areas in Zones 1, 2, and 4. Environmental considerations, land use considerations, and EPA program needs provide the bases for the next section that deals with test systems amenable to an HMSE program in any of the areas described.

# SECTION 5

# ANALYSIS OF TEST ELEMENTS APPLICABLE TO A PROGRAM OF TESTING/DEMONSTRATING EQUIPMENT TO CONTROL HAZARDOUS MATERIALS SPILLS

Three types of testing are feasible in terms of a program to test/demonstrate equipment to control hazardous materials spills. The three elements--open, semi-closed or semi-open, and closed--involve three approaches to the problem of controlled tests of hazardous materials spills. Appendix D, pp. 294 to 302, describes these in more detail; the text that follows is a summary of the comparative analysis of these test elements.

## TEST ELEMENTS: OPEN, SEMI-CLOSED, AND CLOSED

A review of present and projected research involving the design, the operation, and the examination of effectiveness of large-scale equipment designed to control hazardous materials spills illustrates the need of controlled conditions, on a large scale, for the effective demonstration of the feasibility of a wide variety of land and water based techniques. The present and projected EPA hazardous materials research involves primarily three physical conditions: standing water conditions, circulating water conditions, and landspill conditions. These three physical conditions, with proper controls, are capable of being duplicated in three test situations:

1. Open Testing--Test(s) involving the ambient environment, i.e., a stream, river, pond, or meadow. In the strictest sense of definition, open testing involves no construction modifications such as dams, plastic liners, channel improvements, etc.

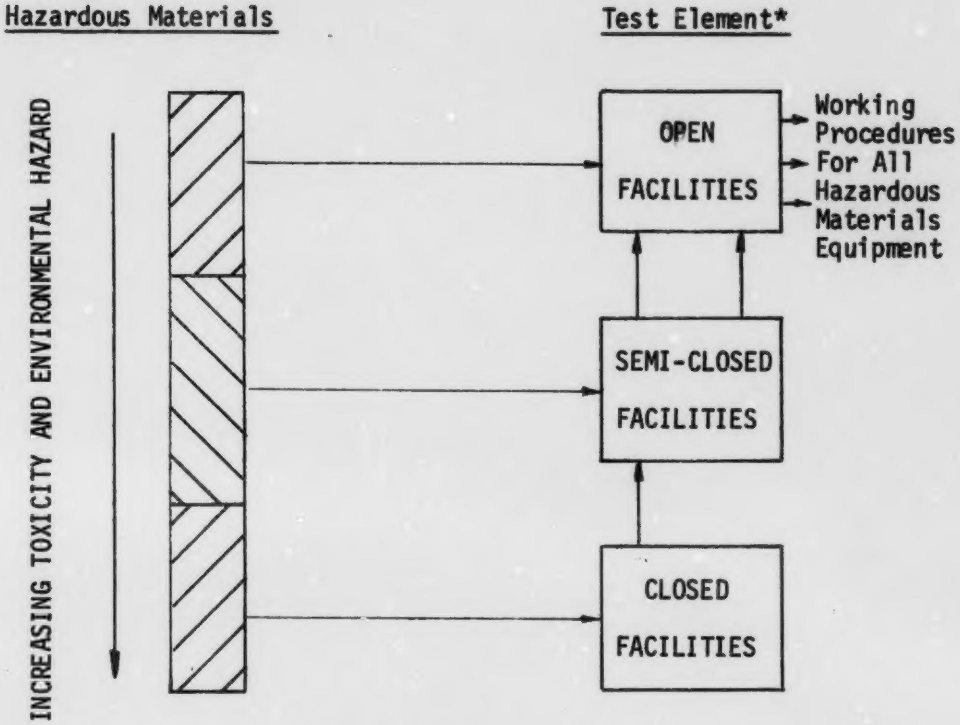
2. Semi-Closed Testing--Test(s) utilizing aspects of the ambient environment with appropriate construction modification for containment/control. Examples include impoundments lined with a plastic sealer, concrete lined stream channels, aquaria, greenhouse facilities, etc. (see pp. 294 to 302).

3. Closed Testing--Test(s) completely contained within an environmental chamber or module; the test therefore is completely divorced from the ambient environment (see pp. 294 to 302).

A wide variety of conditions is capable of being tested in each test element; however, the limiting factors are twofold: (1) controllability of tests is most probable in closed and semi-closed elements--open testing offers varied degrees of control, depending on the site selected, and (2) the most hazardous and/or toxic tests are, in most cases, infeasible of being tested in open conditions, i.e., hydrochloric acid or chlorine spills. Figure 4 illustrates a general principle: the least hazardous tests are usually feasible in open conditions; likewise moderately hazardous tests in semi-closed elements; and the most hazardous tests in closed elements. Hazards and predictability vary

## FIGURE 4

## SCHEMATIC FLOW CHART OF RELATIVE RELATIONSHIP OF DEGREE OF HAZARD VERSUS TYPE OF TEST ELEMENT


Hazardous Materials
Test Element*
INCREASING TOXICITY AND ENVIRONMENTAL HAZARD
OPEN FACILITIES
Working Procedures For All Hazardous Materials Equipment
SEMI-CLOSED FACILITIES
CLOSED FACILITIES

*Ideally, all three test elements should be used to test the most hazardous materials--first in closed, second in semi-closed, and finally in open--this in order to most accurately test and demonstrate the equipment in relationship to controlled and uncontrolled variables.

as a function of the chemical/physical properties of the element of compound being tested; therefore, controllability and selection of an appropriate test element are related to the relative degree of hazard and/or predictability of behavior of the material being tested.

## TEST ELEMENTS IN RELATION TO BASELINE CONDITIONS AT THE MTF

In terms of the candidate areas described in Section 3 and in terms of the MTF in general, the test elements utilized in a Hazardous Materials Spills Equipment Test and Demonstration (HMSE) Facility should satisfy the needs of EPA, while ensuring safey to the environment and the human population. Table 28 in Appendix D illustrates the results of an evaluation of local/regional parameters in relation to open, semi-closed and closed testing. Closed testing, while theoretically safest, provides a wide range of tests with a cost range estimated at $3,500,000 to $6,000,000. Open testing, while theoretically least expensive ($50,000 to $150,000), provides a relatively narrow range of tests with a varied degree of safety (in general, degree of hazard is inversely proportionate to degree of safety). Semi-closed testing offers the benefits of both, with a more moderate cost of $604,000 to $675,000.

Assuming the present and projected needs of EPA remain relatively constant, and assuming cost benefit ratio and environmental safety as paramount guidelines, then the most feasible development would involve a carefully designed semi-closed test facility at the MTF. A schematic design is presented in Section 7, with more specific estimates of costs, capacities, and program direction. The following section deals with the selection/evaluation of a specific site (most amenable to semi-closed testing) and two alternates. Additionally, program expansion is considered.

# SECTION 6

## EVALUATION OF THREE CANDIDATE SITES AT THE MISSISSIPPI TEST FACILITY

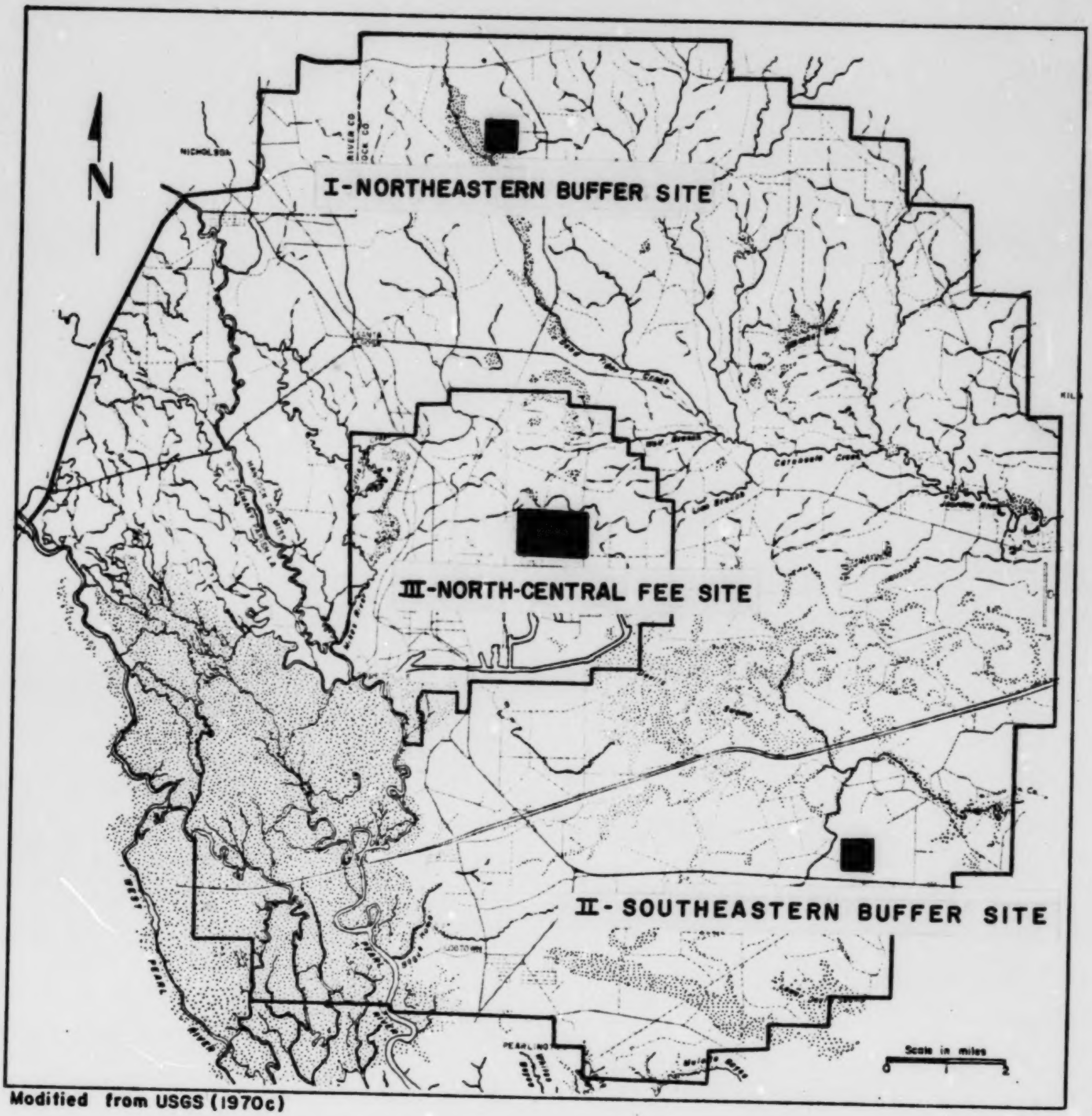
Based on existing environmental baseline data and information, as well as current and projected MTF programs and land-uses, three candidate sites were selected for on-site inspection and survey. Figure 5 shows the locations of these sites. Site I, the Northeastern Buffer Zone site is located 0.6 miles west from Old Highway 43 on a dirt access road that joins Old 43 approximately 4.7 miles north of Gate 11 and approximately 3.5 miles south of the Intersection of Old and New Highway 43 (to the north of the MTF Buffer Zone).

Site II, the Southeastern Buffer Zone site, is located approximately 0.5 miles north of Mississippi State Route 607 on a dirt access road which joins MSR 607 approximately 8.9 miles east of the main south gate of the MTF and 7.6 miles west of the Intersection of Mississippi State Routes 607 (US 90) and 43 in Bay St. Louis. Site III, the North-Central Fee Area, is located on a gravel access road one block north of the MTF Weather Station, off Road L in the Central Fee Area.

### SELECTION OF THE THREE CANDIDATE SITES

The three candidate sites were selected because of many differing attributes. Some of the important attributes involved:

* Nearness to utilities such as electricity and natural gas.
* Ease of access via improved roadways.
* Controllability of ground and surface waters.
* Use of already cleared or partially cleared sites to decrease site construction costs.
* Use of low-value timbered sites.
* Use of relatively low-value sites in terms of general biota.
* Use of sites buffered from public view.
* Use of sites capable of being expanded beyond the present 100-acre boundary lines.


N
NICHOLSON
I-NORTHEASTERN BUFFER SITE
III-NORTH-CENTRAL FEE SITE
II- SOUTHEASTERN BUFFER SITE
WEST PEARL RIVER
PEARL RIVER
Scale in miles
0
1
2

Modified from USGS (1970c)

LOCATION OF THREE CANDIDATE SITES AT THE MTF

Figure 5

- Use of sites not already being used or scheduled for future use by any of the MTF agencies.

Other considerations included avoidance of easily flooded areas and unsuitable soils, and the selection of sites based on the best available topography at the MTF. USGS maps were used to a large extent, both for site selection and for on-site examination.

## RESULTS OF ON-SITE SURVEY AND INVESTIGATION

During the week of November 5, 1973, the three candidate sites were examined to determine relative attributes in terms of testing and demonstrating hazardous materials spills control/removal equipment. Various determinations were made at each site; these include the following:

- Determination of static water levels in shallow wells (depth average = 10 ft ).
- Determination of movement of surface and subsurface water flows.
- Determination of soil properties.
- Determination and mapping of plant communities.
- Observation and determination of potentially valuable natural areas .
- Survey and determination of site features most feasible for development.
- Survey and determination of site features least feasible for development.

These and related aspects are summarized briefly in the following pages. Expanded descriptions, maps, and more detailed data can be found in Appendix C., pp. 249 to 293.

### Hydrology: Methods and Results

Preliminary hydrologic analyses were conducted in the field the week of November 5, 1973. Numerous shallow wells were established at each site to monitor static water levels. Well depths averaged 10 feet below ambient ground levels, and polyvinyl chloride (PVC) well casing with a 2-inch inner diameter was used to shore-up the augered holes. The entire PVC well casing was perforated with numerous 1/32- to 1/16-inch holes to allow free movement of groundwater into and out of the well casing. Measurements of depth (from ground surface) elevation to groundwater for each well were made with an electric depth gauge (as described in Johnson Division, 1966) and recorded three times during the study: 1) initially after installation, 2) five days after installation, and 3) seven days after installation. Groundwater depth relative to ground surface elevation is useful in evaluating direction of groundwater flows, cones of depression of groundwater table, and the amount of surficial materials that separate ground surface from the groundwater table. For depth to groundwater data, see p. 267. For depth to groundwater contours (in relation to surface elevation contours), see figures 7, 9 and 11.

Dye tests were conducted at Sites I and II to better delineate the rates and directions of groundwater flows. After the initial depth to groundwater measurements at the wells at these sites, dye injection wells were established in nearby topographically high areas. Additional observation wells were positioned in proximity to each injection well in nearby topographic lows(lower levels of groundwater in relation to the higher levels at the topographically high injection wells). The locations of these dye injection and dye observation wells are shown in Figures 6 and 8. Of the many dyes and tracers available for groundwater investigations, sodium fluorescein was selected for use because of ease of observation (visually discernable at concentrations as low as 1 ppm) and because other tracers require expensive and/or bulky equipment for measurement of movement or concentrations in the field. Also, the use of sodium fluorescein dye can be applied to a wide variety of sites and conditions without causing significant impact upon the biota or environmental conditions of the area (Davis and DeWiest, 1966).

Approximately one quart of sodium fluorescein dye, with an initial concentration of 595 ppm (super-saturated solution) was injected into each of the topographically high injection wells at Sites I and II. Observation wells were sampled daily during the study in order to detect the presence or absence of the dye in the groundwater. In all cases, no dye was observed in any of the observation wells at the sites; this indicates either (1) no groundwater movement, or (2) the presence of the dye in concentrations lower than 1 ppm. Since the sodium fluorescein solutions in the injection wells did not change significantly during the study (nor did the surface to groundwater levels), it was concluded that very little or no groundwater movements occurred at the sampled sites during the study.

Surface flows were to be measured by means of a pygmy-type current meter; however, quantification of the flows was not possible at the time of inspection, because the intermittent streams on all three sites were either widely diffused or too shallow to measure.

Where low flows were present, surface water pH values were obtained using standard range pH paper. In the surface waters sampled, pH values ranged from 4.0 to 4.5 (intermittent stream in Site I at the junction of the east west access road, see Figure 6; and intermittent stream in Site II at the junction of the two access roads, see Figure 8).

Groundwater pH values were obtained from all wells (with water present) in all three sites. All pH values ranged from 4.0 to 4.5. Measurements were taken two days after the wells were established (this includes injection and observation wells; for locations of wells; see Figures 6 and 8). Other results from the various hydrologic investigations are presented for each individual site below.

## Hydrology: Site I

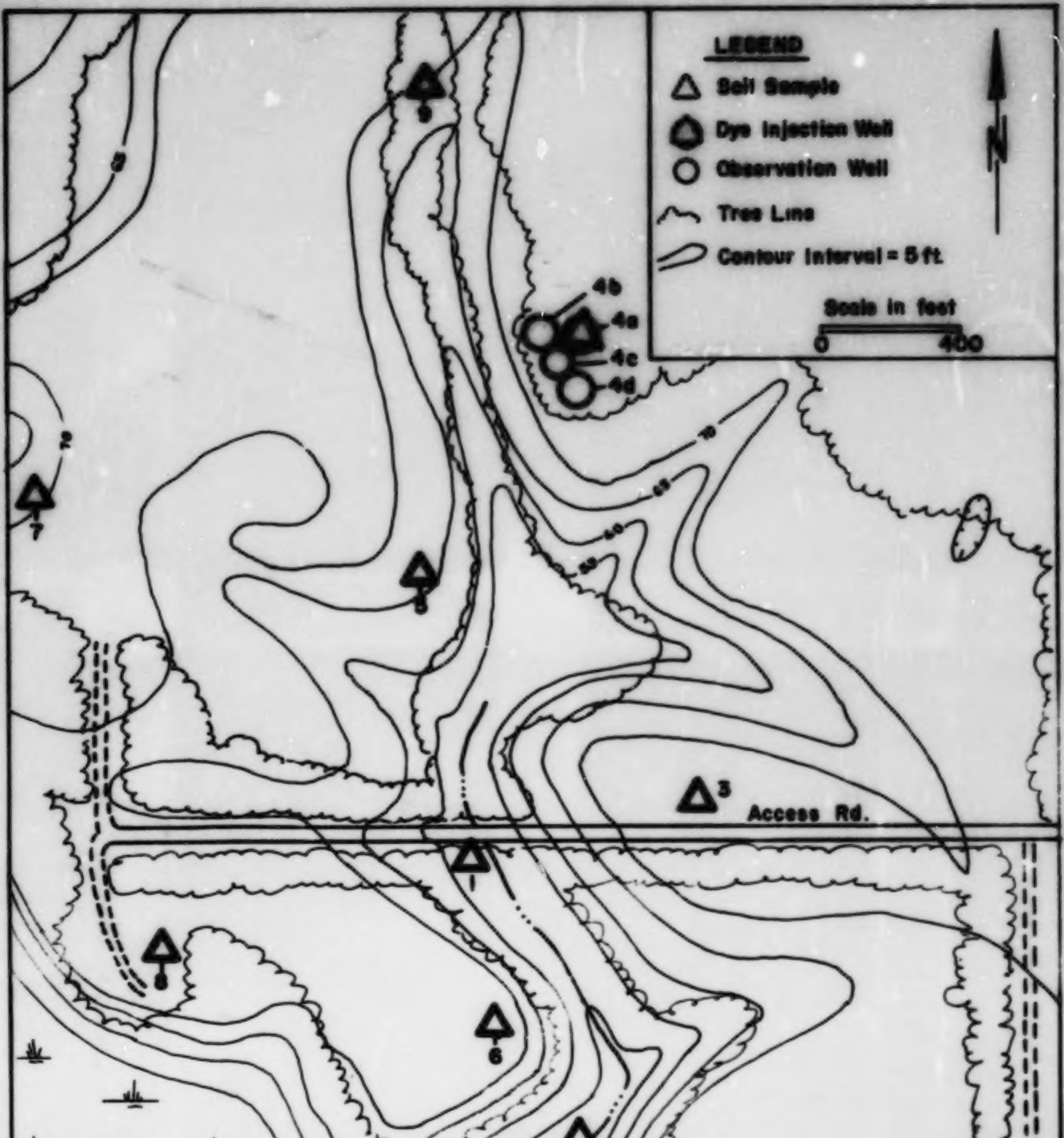
Site I (the Northeast Buffer Site) offers the most topographic expression and, therefore, is the most desired area with the lowest static water table. An unnamed intermittent stream flows through this site and drains directly into Dead Tiger Creek. The flow in this tributary is supported by surface runoff, when available, as well as base flow contributions from the local groundwater system. It appears that the groundwater contribution to the stream occurs throughout the year. North of the access road (see Figure 6) in the center of the site, the drainage pattern is well-defined. A dendritic drainage pattern has developed on the surficial materials, predominantly clays and silts. The stream channel is easily identified and only a few stagnant water areas are present. South of the road, the stream channel becomes diffused and is difficult to distinguish. The area is a backwater zone for the flood plain of Dead Tiger Creek and is a typical swamp or marsh environment. The main stream diverges into numerous distributaries flowing in several directions; however, the overall trend in surface flow is toward Dead Tiger Creek.

As stated, the static groundwater system was delineated by a system of wells placed at strategic locations throughout the basin as shown in Figure 6. The water levels were measured over the study period and used to compile a depth to groundwater map (Figure 7). The groundwater measurements are shown in Table 23. The depth to groundwater map was used in conjunction with topographic maps to determine the direction of groundwater flow indicated in Figure 7. The apparent direction of flow is to the stream and overall to Dead Tiger Creek. These figures indicate only approximate direction and do not consider a velocity factor at all. In order to determine the velocity with which the groundwater migrates, dye was injected at a representative site. After a seven-day period, the dye showed no movement at all indicating that little groundwater movement occurs in this zone, most likely because of the low permeability of the material and the small hydrostatic head.

Our preliminary information for candidate Site I indicates: (1) the area has relatively good surface drainage flowing to Dead Tiger Creek, (2) the groundwater flow system appears to contain no large scale anomalies, (3) the groundwater migrates at low velocities because of the low permeability of the surficial materials, and (4) the apparent direction of the local flow system is to the intermittent stream and Dead Tiger Creek.

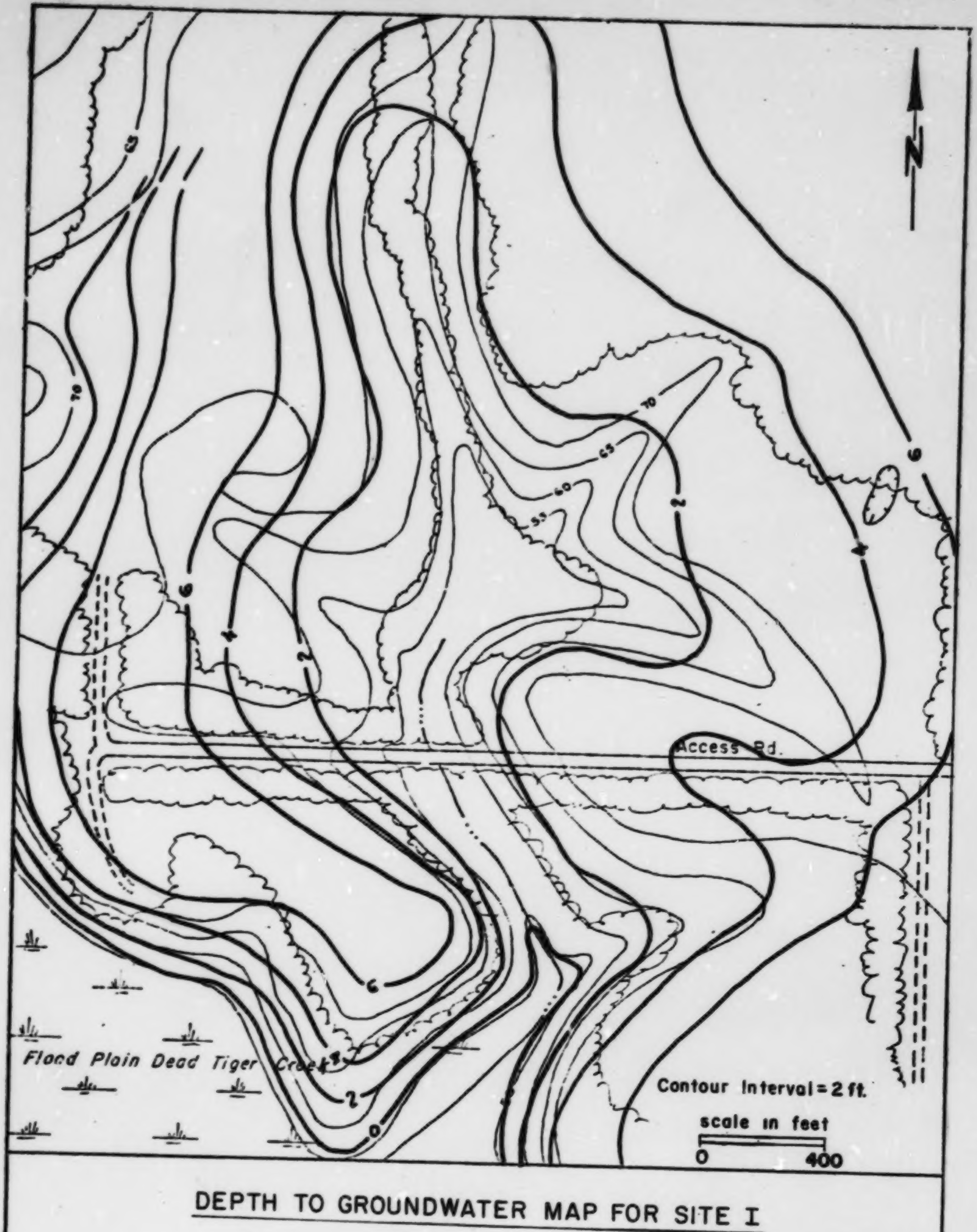
## Hydrology: Site II

Site II possesses little topographic expression. No natural surface stream of any size drains the area; however, man-made drainage channels are present. The fine-grained texture of the surficial



WELL AND SOIL SAMPLE LOCATIONS IN SITE I
THE NORTHEASTERN BUFFER ZONE SITE

Figure 6



DEPTH TO GROUNDWATER MAP FOR SITE I

Figure 7

materials causes areas of ponded surface water to be present. During wet periods of the year, it appears that the area might be much like a flood plain or an extension of Devil's Swamp. It also appears that it might be difficult to keep this site well-drained throughout the year.

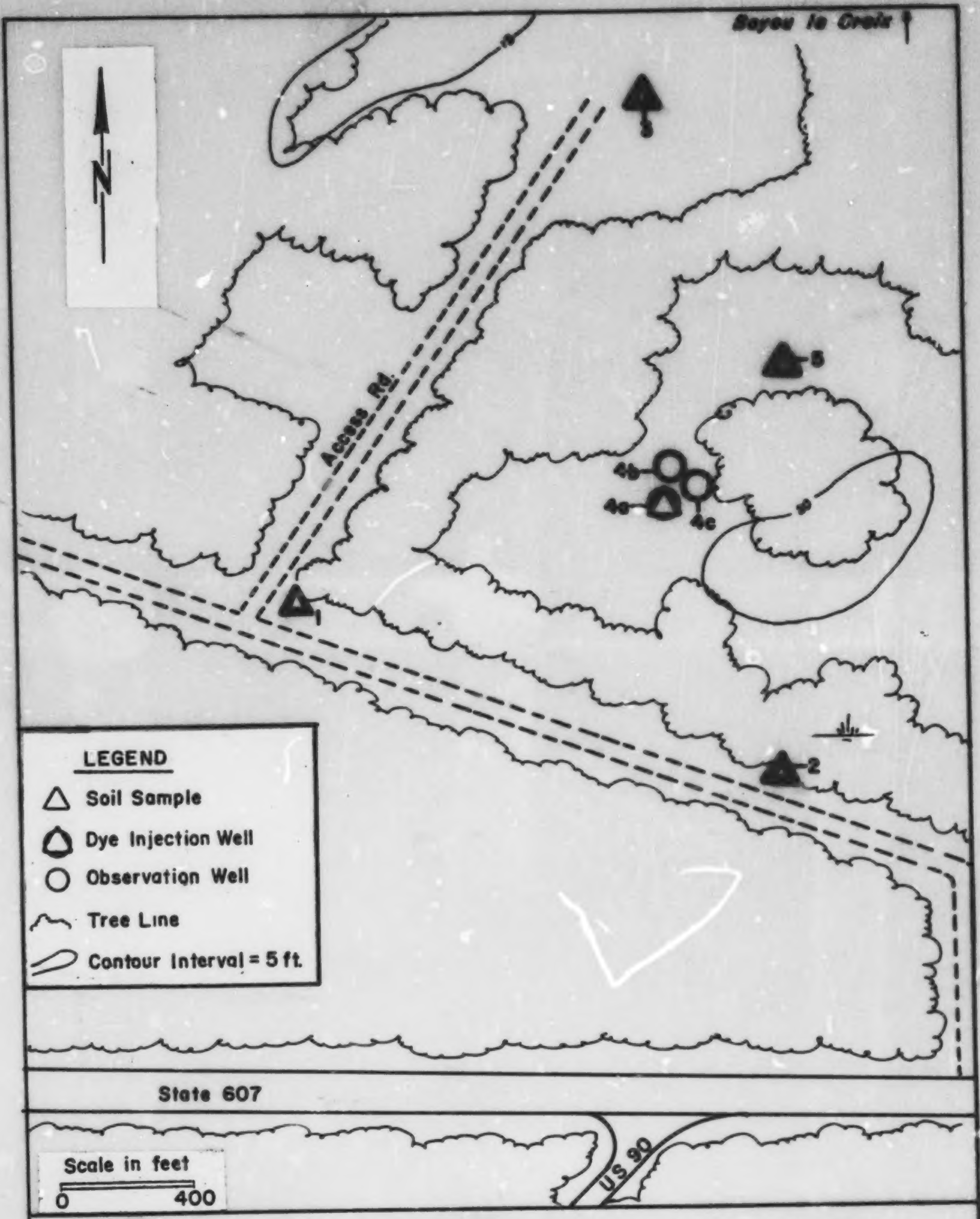
Wells were installed at several locations within the site and dye was injected in the well of highest surficial elevation. The locations of the wells and soil samples collected are shown in Figure 8. A depth to groundwater map (Figure 9) was compiled and the general flow pattern established. The shallow water table conditions indicate that recharge is plentiful and the location is relatively near a groundwater discharge zone. The general pattern of flow of the local groundwater system is radially away from the topographic high; however, very little flow occurs as evidenced by the dye injection test. Dye injected into the well failed to move at all even under a small hydrostatic head produced by injection. This lack of movement indicates a material of low permeability and a low hydrostatic head.

From this preliminary investigation, it appears that Site II is characterized by poor to moderate surface drainage because of topography and the texture of the surficial materials; the groundwater table is very high indicating the area receives a good quantity of recharge; and the groundwater velocity in the area is extremely low because of the permeability of the soil and the low hydrostatic head in the area.

## Hydrology: Site III

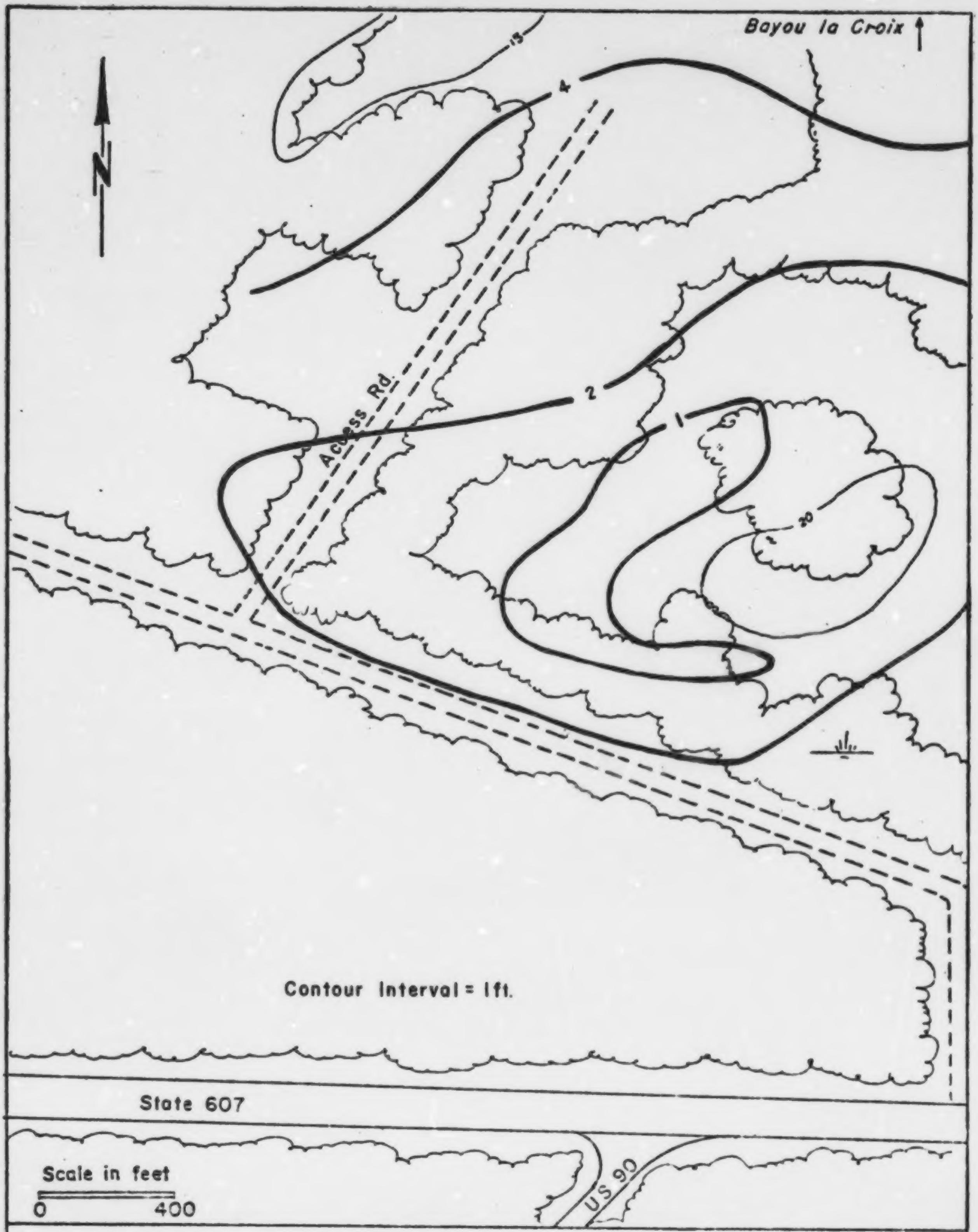
Site III has less topographic expression than Site II, but does contain a flowing surface stream. The stream flows north into Lion Branch of the Catahoula River (Jourdan River System) and is intermittent in nature. This stream is similar to the lower reach of the stream in Site I in that the channel is highly diffused and has a wide, swampy flood plain. There are several stagnant bodies of water within the site and the area is more poorly drained than Site I, mainly because of the lack of large scale differences in elevation. The low flow and diffused nature of the stream made flow measurements impossible in this study.

The absence of a pronounced topographic relief allowed a more simplistic approach to the groundwater analysis. Again, static water levels were measured in wells placed in the area; however, because of the topography, fewer wells were needed (see figure 10 for location of wells). In addition, bore holes were used to locate water levels at random points on the site. This information was used to compile a depth to groundwater map (Figure 11) indicating the general direction of subsurface flow. The nature of the surficial materials was similar to Site I; therefore, no dye injection test to determine groundwater velocities was performed.



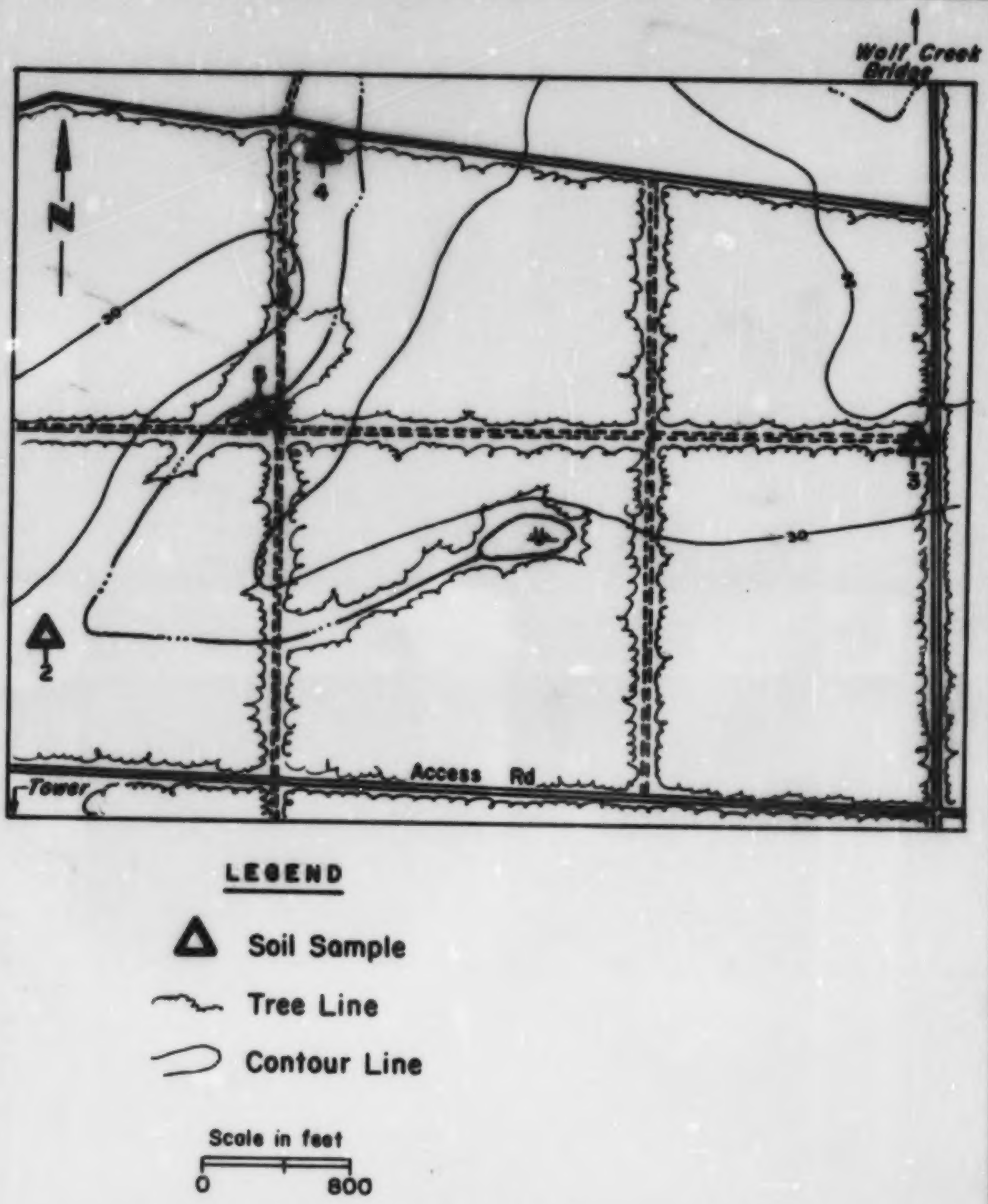
WELL AND SOIL SAMPLE LOCATIONS IN SITE II
THE SOUTHEASTERN BUFFER ZONE SITE

Figure 8



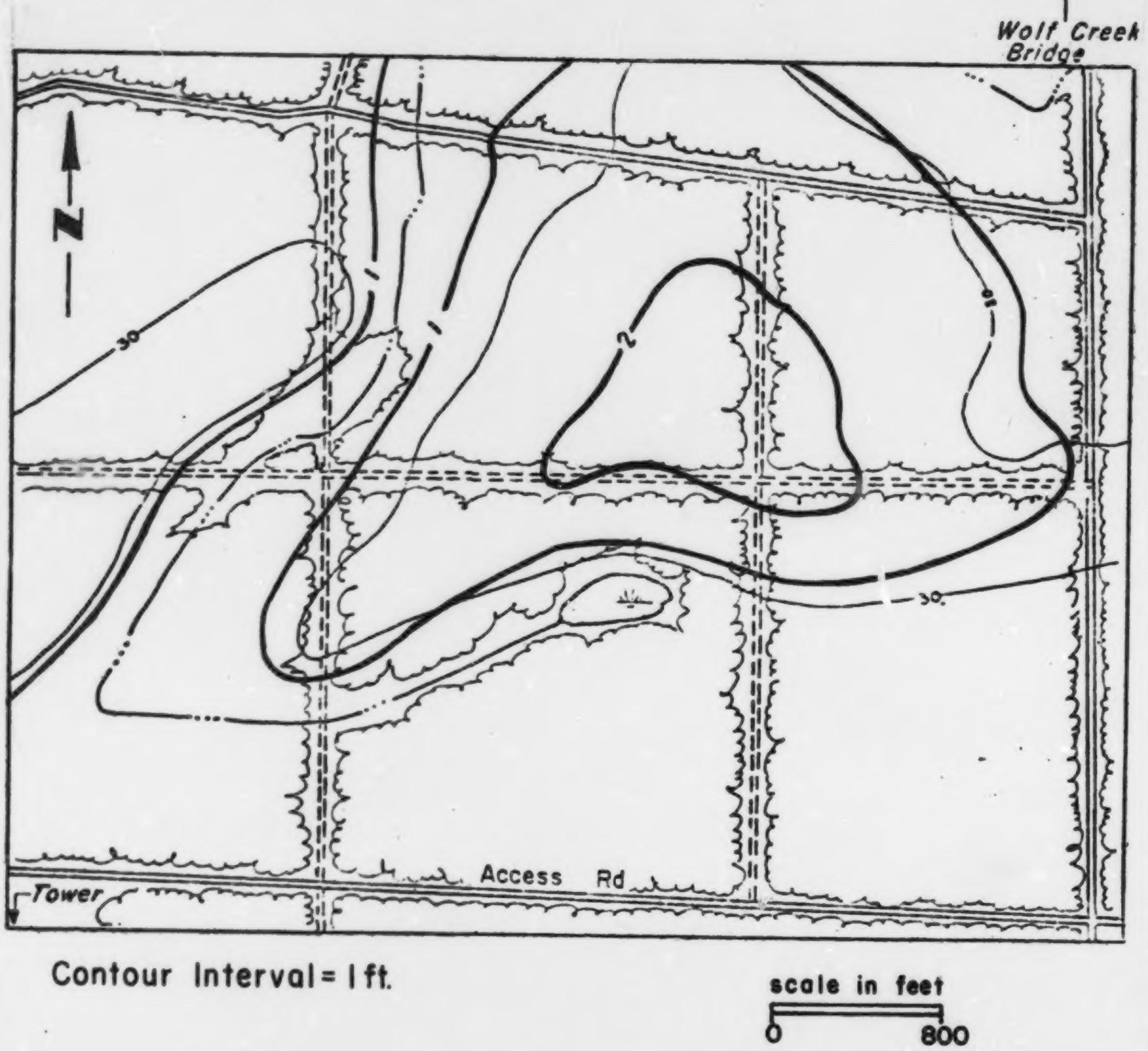
DEPTH TO GROUNDWATER MAP FOR SITE II

Figure 9



WELL AND SOIL SAMPLE LOCATIONS IN SITE III
THE NORTH-CENTRAL FEE SITE

Figure 10



Contour Interval = 1 ft.

DEPTH TO GROUNDWATER MAP FOR SITE III

Figure 11

It appears that two basic trends in the direction of groundwater flow exist. The overall trend in flow is northward to Lion Branch. The second minor flow system supports the intermittent stream on the site and is limited to the areas directly surrounding the stream. The base flow contribution to the stream could not be determined nor could it be determined whether the stream flowed year round.

This preliminary investigation has shown: (1) the area exhibits poor surface drainage although runoff does flow northward to Lion Branch; (2) based on the nature of the surficial materials, the groundwater velocities appear to be low; and (3) although two local flow systems are present, the overall direction of groundwater flow is toward Lion Branch to the north.

## Soils: General

The soils found in the three candidate sites are all very similar in character. All are moderately to poorly drained and consist predominately of clays and silts with some interlayered sand lenses. In low-lying swamp and flood plain regions, the dominant component of the surficial materials is organic muck or fat clay. These areas also contain high quantities of fine-grained sediments, silts and clays, characteristic of a low-energy environment. These materials have a low permeability and are subject to frequent flooding. Quite often these materials can be observed below water level.

The topographically high areas, exemplified by soil sample 1-3, (see pp. 268 to 280 for grain size distribution diagrams), consist also of clays and silts. The original sediments are probably a result of deltaic sedimentation and, consequently, the dominant materials are clays and silts with interlayered sand deposits. Well-drained and moderately drained areas are, thus, a function of the topographic gradient, which promotes or inhibits rapid runoff and drainage of the various areas in the three candidate sites. The more detailed results of the analyses of all soil samples are given in Appendix C, pp. 249 to 293.

During the installation of the groundwater wells, it was found that a lateritic layer was encountered just immediately above the water table. This lateritic layer indicates that vertical movement of groundwater does occur and also serves as a means of locating the water table in topographically high areas. The lateritic layer is the result of a leaching process. A fluctuating water table is necessary for the development of a lateritic because it allows removal of the soluble ions present. The more soluble products are removed in solution and the iron and aluminum remain in place. Thus, the lateritic layer provides a key to locating the local water table.

## Vegetation: General

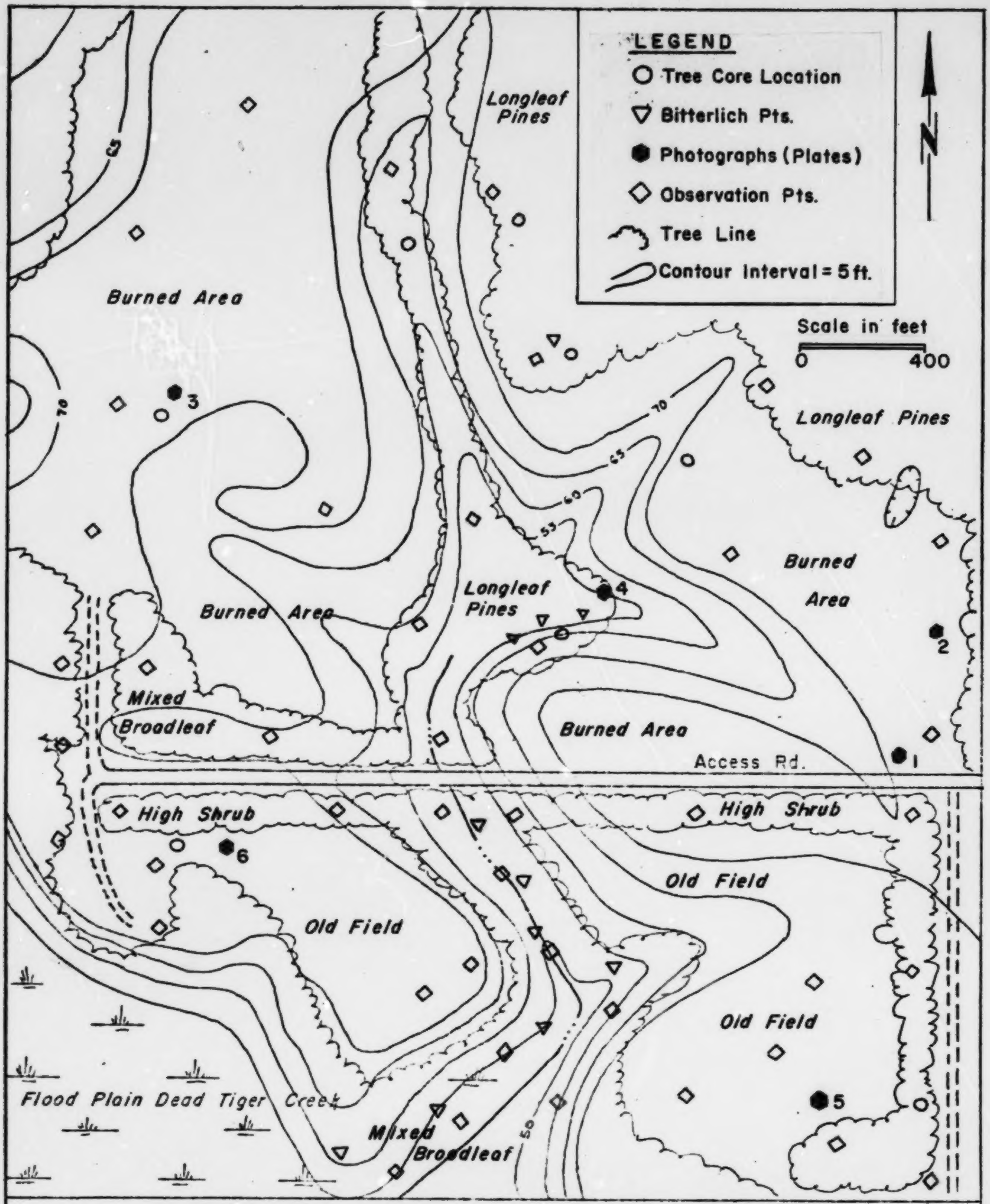
On-site survey and identification of plants, plant associations, plant communities, and plant/substrate relationships were attempted using various techniques. These techniques included: (1) modified-random and selected points sampling of the flora of the sites; (2) observations of physiognomic characteristics of various stands of woody and herbaceous plants; (3) observations of soils, soil-moisture, and plant communities present; (4) modified-random selection of woody species for annual increment core sampling; (5) 10-factor prism determinations of the basal area and frequency of woody species at selected locations; and (6) identification of indicator species for various apparent successional stages at each site. Since on-site work was limited to one week (November 5 - 10,1973), heavy reliance was placed on the local expertise of various persons at the Mississippi State University Research Center at the MTF.

Plant species identified at the MTF can be found in Table 24 on p. 282 in Appendix C. Thirty-five families and fifty-three genera were identified from the sixty-five samples collected. None of the taxa collected and identified can be characterized as rare and/or endangered;however, the possibility exists that certain spring and/or summer blooming species may not be represented in the sampling. Taxa reflecting the ecotonal character of the local flora include northern examples, such as *Rhus vernix* (poison sumac) and *Sphagnum* sp. (sphagnum peat moss). Southern taxa are represented by examples such as *Arundinaria tecta* (cane), *Quercus virginiana* (live oak), and *Tillandsia usneoides* (Spanish moss). Eastern taxa are presented by examples such as *Sarracenia flava* (yellow pitcher plant). Prairie species are also known to exist in the MTF area; these were not collected at the sites surveyed.

Predominant forest trees at each of the three sites are pines: *Pinus palustris* (longleaf pine) in Site I, and *Pinus elliottii* (slash pine) in Sites II and III. *Pinus taeda* (loblolly pine) was observed as a minor member of the pine populations at Sites II and III.

The mixed-broadleaf community (evergreen and deciduous) characterized flood plain areas of Dead Tiger Creek and Wolf Creek, as well as various low-lying, wet areas in all three sites. Common taxa in this community include *Magnolia virginiana* (sweet bay), *Nyssa* spp. (black gums), *Quercus* spp. (oaks), and *Acer rubrum* (red maple). *Taxodium distichum* (bald cypress) and *Ilex opaca* (holly) were frequently encountered both in the pine and in the mixed-broadleaf communities, usually as minor members.

Old field successions were encountered in various areas of Site I (see Figure 12). Three communities were identified qualitatively in the old field areas: (1) pine-mixed grasses, (2) mixed shrub-grasses, and (3) pine-broadleaf tree-mixed shrub. Driest areas



VEGETATIVE SAMPLE LOCATIONS IN SITE I
THE NORTHEASTERN BUFFER ZONE SITE

Figure 12

(sandy soils) were observed to be characteristically inhabited by the pine-mixed grasses community, indicator components of which include Pinus palustris (longleaf pine), Pinus elliottii (slash pine) and Andropogon spp. (broom-sedge grass). Moderately drained areas (clayey-sandy) were observed to be inhabited by mixed shrub-grasses; indicator components including Myrica cerifera (wax myrtle), Ilex vomitoria (yaupon), Ilex coriacea (gallberry), Cyrilla racemiflora (leatherwood), and Andropogon spp. (broom-sedge grass). Minor members often included various pines, goldenrods and scrub oaks. The pine-broadleaf tree-mixed shrub community occupied a wide range of sites (wet and dry, clayey, sandy, and clayey/sandy); indicator taxa were Prunus serotina (black cherry), Carya illinoensis (pecan), Quercus spp. (oaks) Liquidamber styraciflua (sweet gum), and the mixed shrub and Andropogon sp. components described above. Figures 12, 13, and 14 indicate areas inhabited by the various communities at each of the three sites.

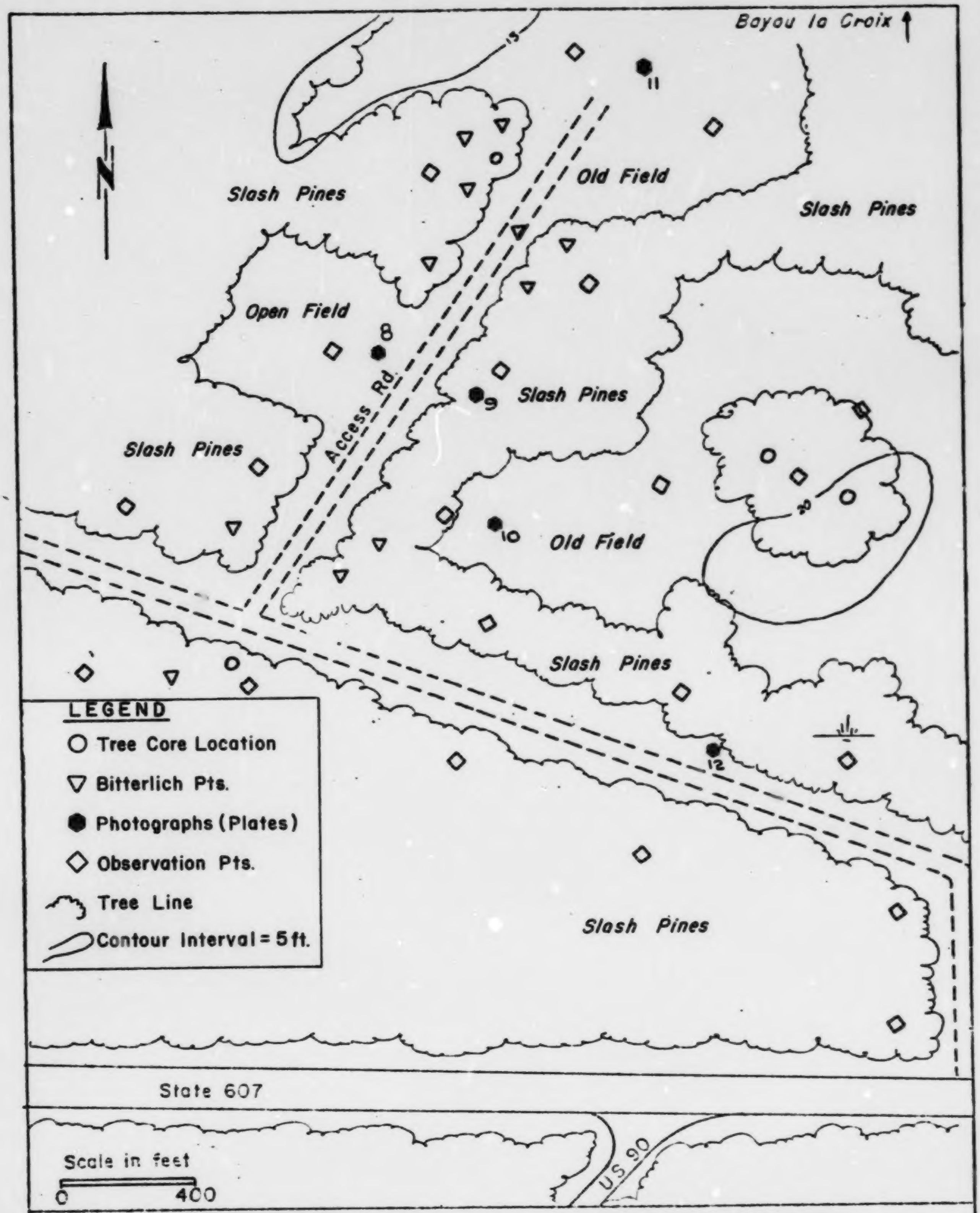
Although the USGS (1970) topographic maps used for the survey indicated many open-field areas at each of the three sites, varied growths of forest and old field communities were encountered instead. Annual increment cores and terminal bud scale analyses obtained in these locations indicated average age trees of 20-25 years; thus, young tree growth was not recorded in the original topographic survey in 1966 or later in the 1970 photo revision.

Substantial open areas in Sites I and II were observed; these apparently have been created and maintained with periodic burnings. Figures 12 and 13 show these open areas. Fire is commonly used to maintain pine plantations at the expense of the more fire-intolerant broadleaf taxa; evidence of this forestry technique was found throughout much of all three sites. Mixed-broadleaf associations in flood plain and wet areas apparently escape these periodic burnings and, thus, contain a wider assortment of species (greater species richness).

Many of the pines in slash pine plantations as well as native stands were observed to be storm damaged, either as a result of Hurricane Camille or as result of more recent storm activity (snow, wind, etc.). In terms of relative forest value, Site I has apparently been recently harvested and not yet reseeded; Site II contains varied stands ranging from early growth (5-9 yrs.) to older growth (20 yrs.), and thus, depending on any particular portion of Site II observed, the value is varied. Site III contains even-aged slash pine plantations (greater than 90% of the site area) of high quality timber (20-30 yrs. in age). Relative timber value, at present, can be ranked as:

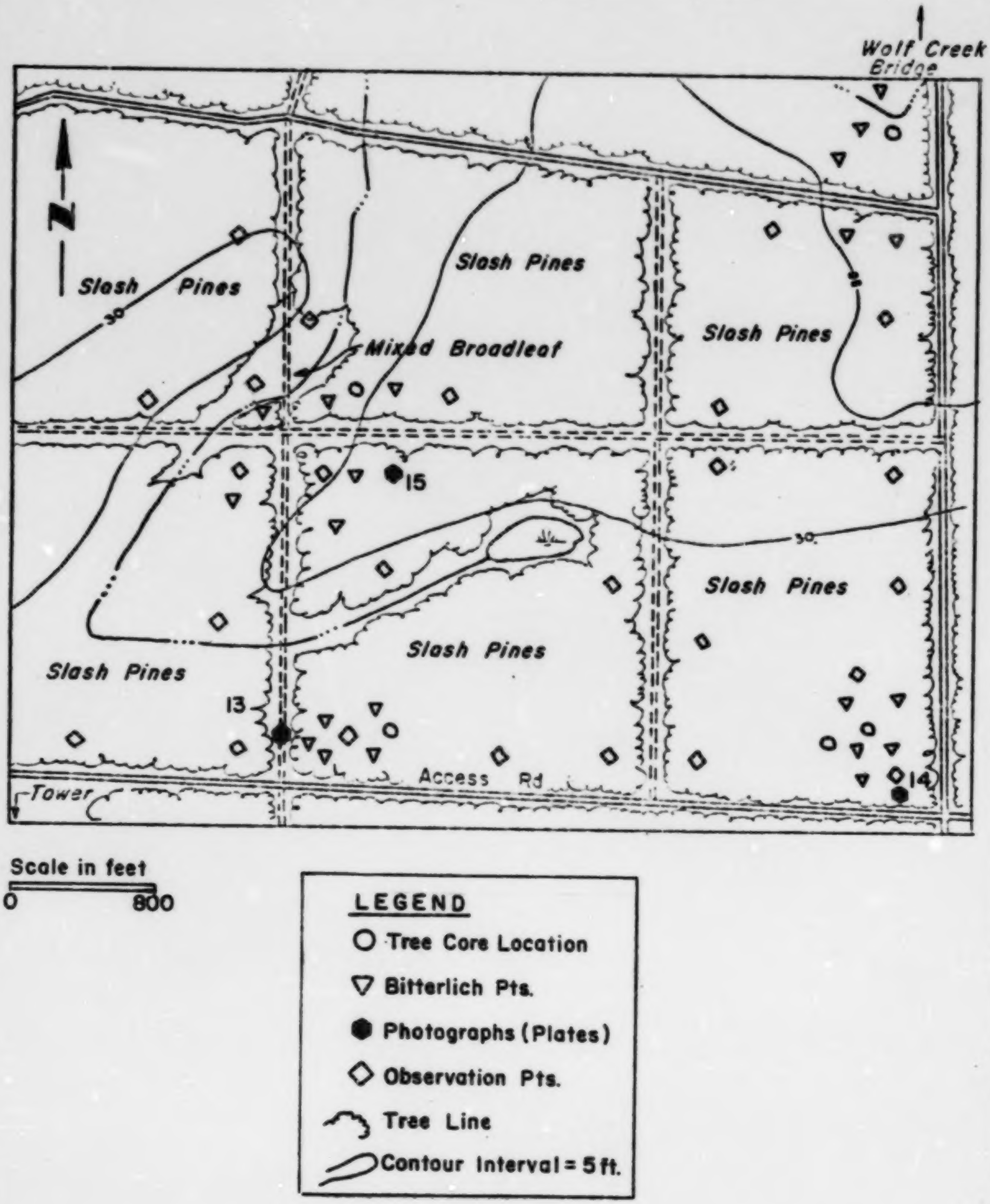
$$\text{Site I} < \text{Site II} < \text{Site III}$$

where Site I has lowest immediate value and Site III has the highest immediate value.



VEGETATIVE SAMPLE LOCATIONS IN SITE II
THE SOUTHEASTERN BUFFER ZONE SITE

Figure 13



VEGETATIVE SAMPLE LOCATIONS IN SITE III-THE NORTH-CENTRAL FEE SITE

Figure 14

In terms of potential damage to natural areas of local or regional value, the flora observed at each site was neither unique nor virgin, and therefore, although interesting scientifically, destruction to or disruption of the three sites would be of little importance to the local scientific and/or naturalist community (assuming erosion and toxicity controls). Also, the apparent rates of vegetative repopulation of denuded areas (vegetative recovery) are high. This is indicated in various locations where roads, farmhouses, and other buildings have been either recently removed or left unmaintained. Native and plantation vegetation have successfully re-established themselves in these areas within a very short period of time (5-10 yrs.).

## Other Important Aspects

In terms of site evaluation, each of the three candidate sites possessed qualities other than those already described. In terms of topographic relief, the respective topographic highs and lows for Sites I, II, and III are 75 to 50-55 feet above mean sea level (msl), 20 to 5-10 feet above msl, and 30 to 20-25 feet above msl. Thus, Site I offers a varied topographic relief (well-drained to moderately well-drained); Site II is less topographically defined (moderately to poorly drained); and Site III is essentially flat (moderately to poorly drained). Topographic lows of 10 ft. above msl are generally characterized by frequent flooding, and thus should be avoided unless adequate provisions are made to ensure elevation of buildings and structures. Portions of Sites II and III are subject to periodic flooding; these flood areas could feasibly be avoided by wise placement of structures and facilities. Section 7 of this report will offer suggestions in this regard.

Drainage from the three sites enters small streams or tributaries that are well removed from main-stem rivers and streams. Drainage from Sites I, II, and III enters respectively Dead Tiger Creek (the Jourdan River System), an unnamed tributary (the Bayou La Croix System), and Lion Branch (the Jourdan River System). These drainage aspects provide the best controlled conditions available at the MTF (see also Appendix C).

In terms of biota, other than that already described, man-associated activities have already destroyed or otherwise altered native populations at the three sites. Animals observed at the three sites included pigs and cattle (escaped populations), nutria, squirrel, various snakes, turtles, frogs, and birds -- none of which are rare and/or endangered at present. Populations of the above animals would be capable of adjusting to construction activities at the three sites. Because of the short time available for on-site study, the possibility does exist that some highly valued animals and plants may not have been observed.

Access roads to the three sites are either dirt (Sites I and II) or gravel and shells (Site III). Improvements would have to be made to support heavy equipment such as trucks, tankers, etc. The present roads, when dry, are capable of being traveled by jeep or by passenger car. All access roads to the three sites are within one mile in length, and all three access roads connect to heavy-duty paved roadways: Old MSR 43 (Site I), MSR 607-US 90 (Site II), and Road L in the Central Fee Area (Site III).

Utilities such as natural gas and electricity are available to all three sites, provided extensions are made or portable units are employed. Coast Electric or Mississippi Power are available to serve the three sites, and gas lines may be tapped near Gate 11 or at any serviceable location of the many miles of pipeline at the MTF. Distances from already available electric and telephone lines for each site are given below:

| | |
|---|---|
| * Site I | - 2.6 miles, north on Old Highway 43 |
| * Site II | - 0.2 miles, east on MSR 607 (US 90) |
| * Site III | - 0.5 miles, south, Road L conduits |

Utilities may be obtained through the local companies or by arrangement with Global Associates, the operator/contractor designate for the MTF.

Site acquisition is expected to be arranged with NASA-MTF. Buffer Zone sites (I and II) are either leased or owned by NASA; purchase by EPA is therefore not necessary. Lease arrangements with NASA for any of the three sites are expected to be easily obtained, when the exact needs for the project are determined.

Finally, the following pages contain Plates 1 to 15, which illustrate various features of the three sites. Close examination of these plates will reveal many of the topographic, hydrologic, biotic, and transportation aspects peculiar to the three candidate sites at the MTF.

## COMPARATIVE EVALUATION OF RESULTS

The results of the site survey and investigations at the MTF indicate Site I, the Northeastern Buffer Zone site, as the most feasible of the three candidate sites for development of a facility to test/demonstrate equipment to control Hazardous Materials Spills. Factors which are important to the flexible design of a facility include:

- Controllable surface water conditions.
- Controllable groundwater conditions.
- Favorable soils conditions.
- High vegetative recovery conditions.
- Varying topography.
- Easy access in terms of transportation.
- Isolation from public view.

PLATE 1 - Site I. View of burned and harvested area north of access road (see Figures 12, 13, and 14 for exact locations of plates).

PLATE 2 - Site I. View of northeast periphery of burned area.

PLATE 3 - Site I. View of northwest periphery of burned area with Dead Tiger Creek in background. Tree in foreground is a longleaf pine "seed tree."

PLATE 4 - Site I. Fire-break around the remaining trees in center of burned area near intermittent stream. Trees are longleaf pine. Grass stage trees are in foreground.

PLATE 5 - Site I. Old field area in southeast of site. Trees are longleaf pines, grasses are broomsedge, and the area is well-drained.

PLATE 6 - Site I. Old field area in southwest site. Trees are longleaf pines, grasses are broomsedge, and the area is well-drained. Background trees mark the junction of Site I intermittent stream and Dead Tiger Creek.

PLATE 7 - Site II. View northward along access road. Trees are slash pines, grasses are broomsedges, and the area is poorly to moderately drained.

PLATE 8 - Site II. View of open field to west of access road. Evidence of fire is present (base of slash pines) and the area is moderately drained.

PLATE 9 - Site II. Slash pine plantation to the east of the access road. Area is poorly to moderately drained.

PLATE 10 - Site II. View of topographically high area (20 ft. msl) showing slash pine and broomsedges on moderately drained soils.

PLATE 11 - Site II. View of northern periphery of site; trees in background indicate edge of Bayou La Croix area (topographically low and poorly drained).

PLATE 12 - Site II. View of southern edge of site, slash and longleaf pines, broomsedges and poorly to moderately drained soils.

PLATE 13 - Site III. View of side road northward from east-west access road. Area is poorly to moderately drained and planted with slash pines.

PLATE 14 - Site III. View of slash pine and mixed shrubs from southeast corner of site. Area is moderately drained.

PLATE 15 - Site III. View of slash pine plantation in center of site. Area is essentially topographically flat and moderately drained.

These assets are most favorable at Site I, as are described in this section and in more detail in Appendix C. Other favorable conditions are related to present land uses and values. Since all three candidate sites are chiefly used for forestry, Site I possesses least immediate value, having been harvested recently. The burned and harvested area north of the access road would aid significantly in reducing construction costs, since it has been cleared and has a reasonable grade at present. Additionally, the previous forestry techniques have eliminated most valuable natural aspects of the site, thus construction on Site I would have least impact on locally valuable or endangered populations of various plants and animals. Altogether, these assets indicate:

* Lower site preparation costs.
* Lower construction costs.
* More adequate controls possible as backups to tests.
* More flexibility in program design.

These items are illustrated in Section 7 in the schematic semi-closed test facility design for Site I.

In terms of Sites II and III, provisions for drainage must be made (1) to control sluggish surface water drainage, (2) to prevent puddling and ponding during periods of moderate to intense rainfall, and (3) to lower subsurface water levels. Use of fill dirt, drainage tiles, and channel improvements would be necessary as baseline site preparations. Additionally, the clearing of woody plants (pine forests and mixed shrubs) appears to be a necessity at Sites II and III; this factor would increase site preparation costs.

In terms of construction, fill dirt would be necessary to construct a stream gradient approaching 5-10 ft /mile. A greater gradient would necessitate a greater amount of fill dirt. In general, flat topography along with high water tables would necessitate construction of facilities at greater costs; these costs would be involved with:

* Maintenance of controlled groundwater conditions (separation of test conditions from water table conditions).

* Control of surface runoff and flood prevention during moderate to high periods of precipitation.

* Establishment of larger, shallower reservoirs to accommodate stream flow needs at the facility.

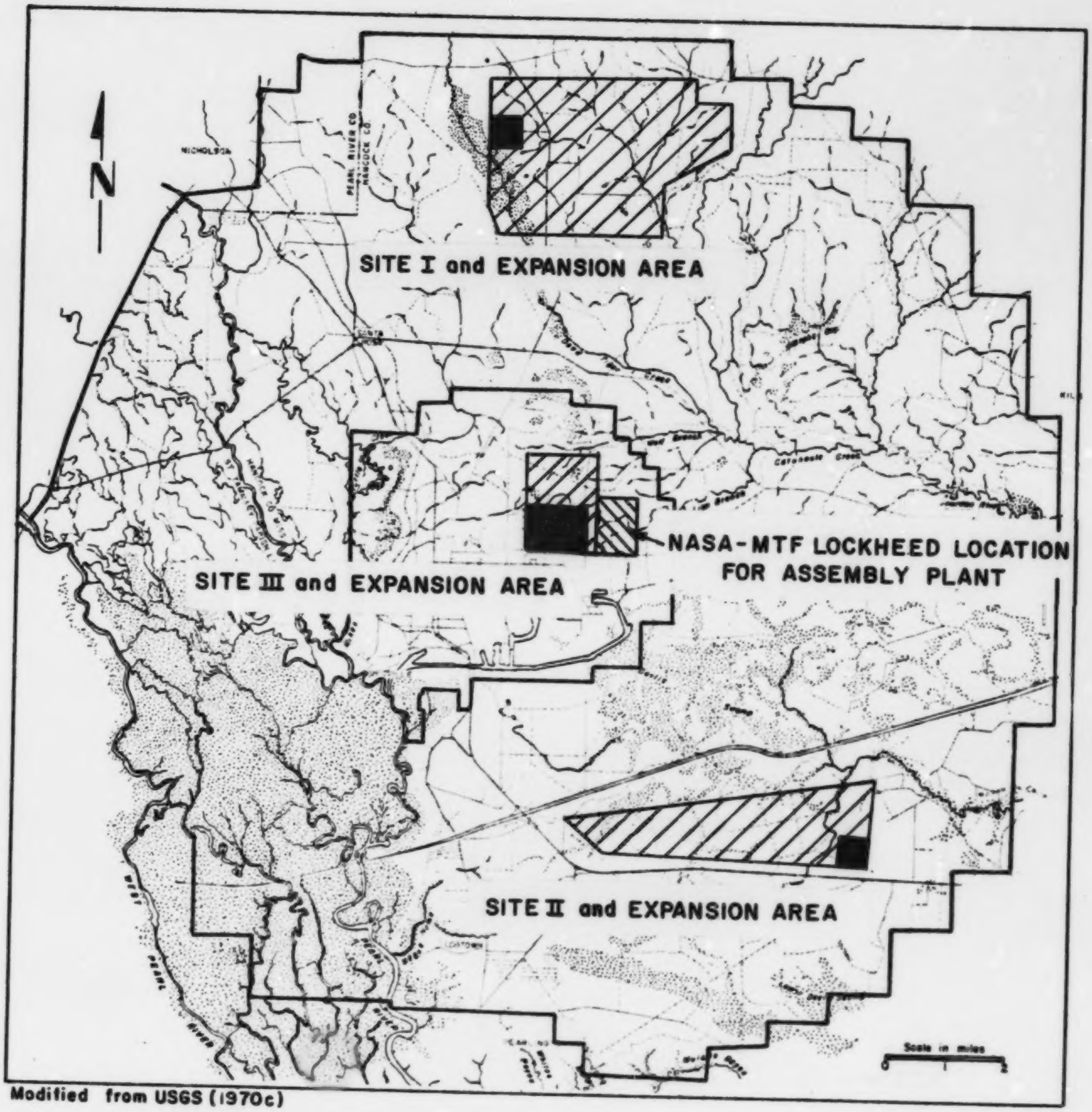
These factors are treated in more detail in Section 7 in the schematic facility description.

Finally, expansion beyond the present site boundary lines appears to be an important part of present EPA needs. Expansion in Sites I and II is governed by test needs; expansion in Site III is additionally governed by present and projected land uses to the south and east. Lockheed Corporation and NASA-MTF are presently planning construction of an assembly facility near Site III (North-Central Fee Site), see Figure 15. This development would seriously hinder or eliminate an EPA program at Site III. Additionally, Site III is bounded to the immediate west by the Pearl River Drainage System, which should not be developed, and to the north by Wolf Creek, which offers a swampy area inconducive to most EPA program needs.

Site II is bounded to the North, the West, and the South by highways: I-10, MSR 607, and US 90. Potential for site expansion is governed by these developments and test needs. Much of the expansion area is floodplain/swamp; however, these wet conditions might enhance the variety of tests possible in future programs.

Site I offers a large expansion area with varied topography and landscape features. Rolling hills, stream valleys, swamps, and interfacing features provide the widest possible range of test conditions available at the MTF.

In summary, Site I offers the largest variety of test conditions at the MTF and this, together with many other factors, makes the site and potential expansion area most attractive to the program needs of EPA. A program established at Site I could incorporate the USGS floodplain facilities (see Appendices B and C) and/or Sites II and III as additional supportive test sites. The role of supportive test sites would need to be better defined in the engineering design of the program.


N
NICHOLSON
PEARL RIVER CO.
HANCOCK CO.
SITE I and EXPANSION AREA
SITE III and EXPANSION AREA
NASA-MTF LOCKHEED LOCATION FOR ASSEMBLY PLANT
SITE II and EXPANSION AREA
Scale in miles
0
1
2

Modified from USGS (1970c)

LOCATION OF THREE CANDIDATE SITES AND POTENTIAL EXPANSION AREAS

Figure 15

## SECTION 7

## A SCHEMATIC SEMI-CLOSED TEST FACILITY DESIGN

As described in Section 5, the semi-closed test elements most suitable for present and projected EPA hazardous materials program needs include a stream channel, a reservoir/test ponds unit, and a landspill test unit. These elements are also conducive to test controls and thus environmental protection. These elements would provide useful and safe conditions for the testing/demonstration of equipment to control hazardous materials spills. The following section describes a schematic testing facility at Site I, the Northeastern Buffer Zone site. Included in the description are cost estimates and capacities of the elements, with the emphasis on controllability of tests assuming a twelve-inch rainfall during testing and/or an accidental release of materials at the site. Containment controls and detailed engineering/program design are not included here; these aspects should be completed in a later phase of the program.

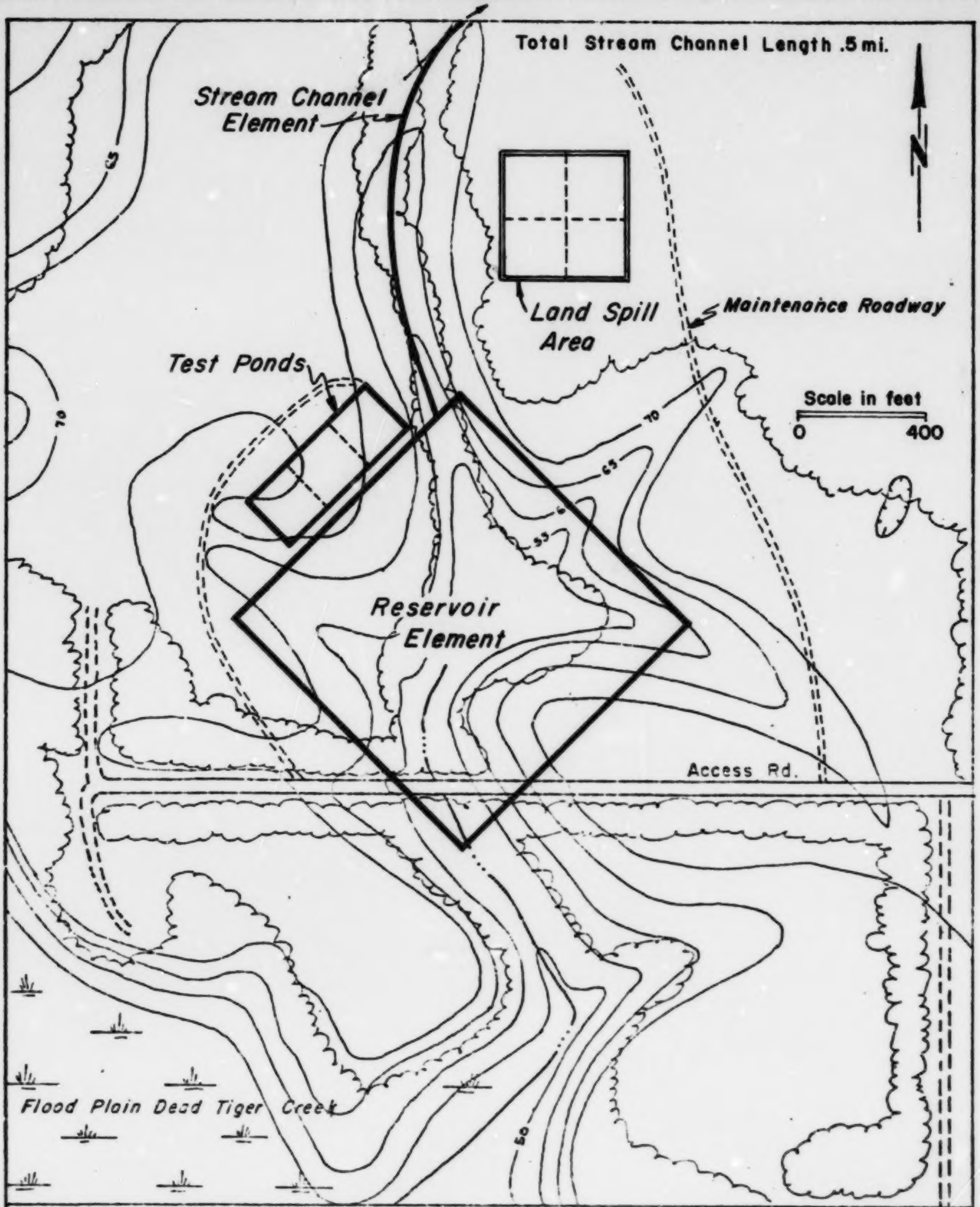
### SITE PREPARATION AND SCHEMATIC DESIGN

Figure 16 shows the location of three test elements at Site I. The test elements are situated to take advantage of topographic relief, existing intermittent water-course features, and the existing access road and burned/cleared area. Additionally, the test elements are located such that simultaneous testing is feasible in landspill, test ponds, and stream elements.

Test elements, depending on actual sizes and uses, could be modified in size and thus expanded (or contracted) beyond the illustration in Figure 16. Costs, capacities, and element needs should be adjusted respectively. Appropriate controls should be varied also; thus, reservoir size (depth, surface area, etc.) could be modified to any wide range of needs. Included below are sample capacities, needs, and cost estimates for the various elements of the schematic design.

#### Stream Channel and Reservoir Element

Three stream channel widths (10, 15 and 25 ft) and two stream gradients (10 ft/mile and 20 ft/mile) would provide a range of (min-max) adequate flows for present and projected moving-water needs. A reservoir designed to contain the total volume for a 3-hour flow period with the above combinations, plus a twelve-inch rainfall control provision would vary in capacity as follows:



SCHEMATIC SEMI-OPEN FACILITY AT SITE I

THE NORTHEASTERN BUFFER ZONE SITE

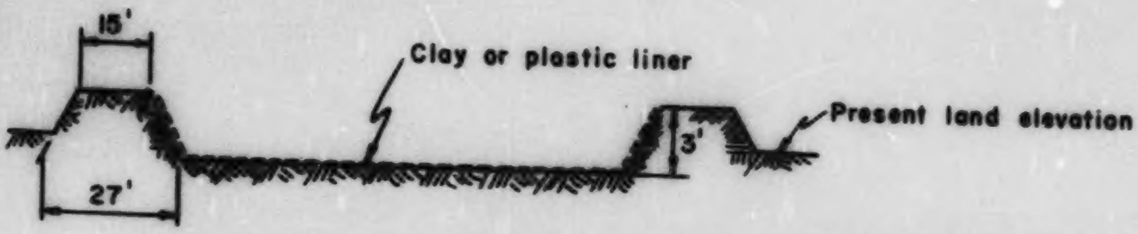
Figure 16

| STREAM WIDTH(Ft) | LENGTH(Ft) | GRADIENT(Ft/Mi) | RESERVOIR CAPACITY (Acre-Ft) |
|---|---|---|---|
| 10 | 2640 | 10 | 50 |
| 15 | 2640 | 10 | 75 |
| 25 | 2640 | 10 | 125 |
| 10 | 2640 | 20 | 70 |
| 15 | 2640 | 20 | 105 |
| 25 | 2640 | 20 | 200 |

Capacities would vary with degree of stream channel obstruction (islands, vegetation, etc.); therefore, calculations are based on a clean channel maximum use. Variation in values would occur with modification of gradient, length, width, or duration of flow in the channel. Similar variations would be reflected in altered capacities, etc., of the respective receiving reservoirs. Based on present EPA program needs, the 10 foot wide, 2640 foot long stream channel with a gradient of 10 ft/mile and a 50 acre-foot capacity reservoir would provide adequate test conditions for moving water test/demonstration.

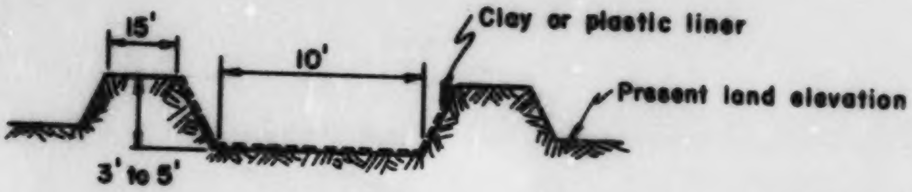
The stream channel, as described above, should be lined with plastic and/or compacted clays and should be 10 feet wide at base and 3 feet deep, with provision to include maximum stream flow plus a 12-inch rainfall runoff, this at the exclusion of runoff from surrounding topography. Thus, provision for diking is indicated, the exact dimensions vary as a function of stream channel size and topographic variation. Variation in design would be determined at a later time in the engineering design phase of the program. Dikes for a 50 acre-foot capacity reservoir should be 27 feet wide at base, 15 feet wide at top, and 3 feet above the floor of the reservoir (depth of reservoir floor should be approximately 1-2 feet below present land elevations (see Figure 17). The reservoir floor and walls should be lined with plastic and/or compacted clay and designed to be completely impermeable.

Estimating earthen fill need and excavation costs, construction equipment costs and plastic liner or clay liner costs, the 50 acre-foot capacity reservoir and stream channel element would cost an estimated $127,550.



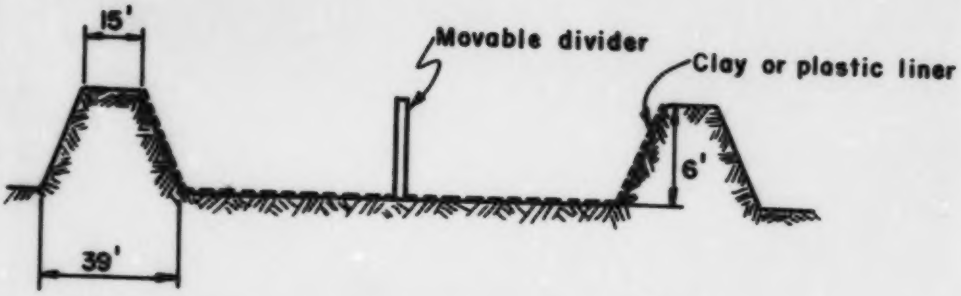
Capacity: 50 Acre Ft.

Cross Section of Reservoir at Site I



width = 10'
length = .5 mile
gradient = 10 ft./mile
flow = 116 cu. ft./sec.

Cross Section of Stream Channel



Sample Landspill Element Design

SCHEMATIC CROSS SECTIONS OF ELEMENTS IN TEST FACILITY DESIGN AT SITE I

Figure 17

## Test Ponds

Test ponds construction, as illustrated in Figure 17, should be designed similarly to reservoir specifications (diking, clay/plastic liners, 12-inch rainfall allowances, etc.). Figure 17 shows a schematic cross-section diagram of a test pond unit The cost of the illustrated unit is estimated at $84,800.

## Landspill Element

Landspill test elements, as illustrated in Figures 16 and 17, should be plastic or clay-lined, tiled, and capable of assuming a 12-inch rainfall without contamination of surface or groundwater supplies. Estimated cost of such a landspill unit is $88,000.

EPA owns and operates a mobile clean-up/treatment facility which could be moved to any particular test element as needs dictate. This would eliminate the cost of expensive treatment plant facilities, provided tests and capability of the mobile facility are comparable. Improved roadways would be needed for this purpose. An estimated 1.6 miles of roadways improvement would be necessary (including the 0.6 mile access road to Old Highway 43); the cost of such improvements estimated is at $42,500.

Total cost of elements and supporting element needs (tiles, landscaping, etc.) is estimated at $503,550. This estimate is subject to change due to increases in construction costs, materials, etc.

A three-phase development program for such a facility as illustrated in Figures 16 and 17 should be initiated as follows:

(1) An engineering design, construction, and operation phase should include elements as described in this section; total cost of this phase is estimated at $503,550.

(2) Initial and continuing environmental monitoring/surveillance should be begun concurrently with (1) in order to better quantify the environmental baseline conditions and responses to a testing program at Site I; the estimated cost is $50,000.

(3) An examination of future needs of a program at Site I (open testing, expansion of site, use of supportive sites, use of USGS facilities, and the role of a multi-dimensional approach) should be conducted; the estimated cost is $50,000.

Total forecasted cost for the three-phase development program is estimated to be $604,000. Included in the cost estimate are utilities expansion (electrical, phone) and establishment and initial testing of a deep well (capacity 116 cubic feet/second or 52,084 gallons/minute).

## SUMMARY OF COST ESTIMATES FOR A FACILITY AT SITE I

The following represents a brief outline of forecasted costs for the development of the three-phase program at Site I. Cost estimates are a function of time, e.g., inflation. If the three-phase program were to begin in the near future, the cost breakdown would be as follows:

### CONSTRUCTION COSTS: RESERVOIR

| | |
|---|---|
| * 80,000 cubic yards of excavation | $ 47,000 |
| * Clearing and grading of 10 acres | 3,000 |
| * 2,600 cubic yards of embankment preparation | 5,000 |
| * Miscellaneous piping and bypass structures | 7,500 |
| * 13,000 square feet of clay liner | 6,100 |
| * Pump station and electrical | 15,000 |
| TOTAL ESTIMATED COST: RESERVOIR | $ 83,600 |

### CONSTRUCTION COSTS: STREAM CHANNEL

| | |
|---|---|
| * 2,000 cubic yards of excavation | $ 1,500 |
| * 2,000 cubic yards of embankment preparation | 3,800 |
| * 62,500 square feet of plastic liner | 31,250 |
| * Erosion controls | 7,500 |
| TOTAL ESTIMATED COST: STREAM CHANNEL | $ 44,050 |

### CONSTRUCTION COSTS: TEST PONDS

| | |
|---|---|
| * 4 acres of clearing and grading | $ 2,000 |
| * 20,000 cubic yards of excavation | 15,000 |

## CONSTRUCTION COSTS: TEST PONDS, CONT'D

| | |
|---|---|
| * 1,500 cubic yards of embankment preparation | $ 2,800 |
| * 1,000 linear feet of 12-inch sewer piping | 5,000 |
| * 120,000 square feet of plastic liner | 60,000 |
| TOTAL ESTIMATED COST: TEST PONDS | $ 84,800 |

## CONSTRUCTION COSTS: LANDSPILL UNIT

| | |
|---|---|
| * 4 acres of clearing and grading | $ 2,000 |
| * 9,000 cubic yards of embankment preparation | 18,000 |
| * 32,000 linear feet of perforated 6-inch drain tile | 48,000 |
| * 1,000 linear feet of 12-inch sewer piping | 5,000 |
| * Miscellaneous piping | 10,000 |
| * Moveable barriers | 5,000 |
| TOTAL ESTIMATED COST: LANDSPILL UNIT | $ 88,000 |

## CONSTRUCTION COSTS: OTHER

| | |
|---|---|
| * 8,500 linear feet of roadway | $ 42,500 |
| * Establish on-site utilities | 10,000 |
| * Deep well installation | 15,000 |
| * Miscellaneous site improvements | 10,000 |
| * Waste treatment plant and pumping station | 50,000 |
| * Fencing and storage facilities | 10,000 |
| TOTAL ESTIMATED COST: OTHER | $137,500 |

## CONSTRUCTION, ENGINEERING AND CONTRACTOR COSTS

| | |
|---|---|
| * Total construction costs above (reservoir, stream channel, landspill units, test ponds and other) | $437,950 |
| * Engineering design and contractor costs | 65,600 |
| TOTAL ABOVE COSTS | $503,550 |

### ENVIRONMENTAL MONITORING AND SURVEILLANCE COSTS

| | |
|---|---|
| * Ground and surface water quality and quantity | $ 25,000 |
| * Biotic baseline and changes | 20,000 |
| * Other site studies | 5,000 |
| TOTAL MONITORING AND SURVEILLANCE COSTS | $ 50,000 |

### PREPARATION OF DETAILED OPERATIONAL PLAN

| | |
|---|---|
| * Facilities' capacities and potential range of uses | $ 20,000 |
| * Expansion capabilities of the program at the MTF | 20,000 |
| * Coordination of uses with other agencies and use of other-agency facilities | 5,000 |
| * Other | 5,000 |
| TOTAL DETAILED OPERATIONAL PLAN | $ 50,000 |

### TOTAL COST OF THREE-PHASE DEVELOPMENT PROGRAM

| | |
|---|---|
| * Total construction costs | $ 503,550 |
| * Total monitoring/surveillance program | 50,000 |
| * Detailed operational plan | 50,000 |
| TOTAL PROGRAM ESTIMATE | $ 603,550 |

The cost estimates shown in these pages would allow the construction of the following at Site I:

- A 50 acre-foot reservoir (dimensions flexible to fit contours of site).
- A 2,500 foot long stream channel (10 feet wide at stream bottom surrounded with a 2 foot high embankment (at minimum).
- A test pond area with dimensions of 200 feet by 550 feet surrounded by a 5 foot embankment.
- Landspill unit with dimensions of 400 feet by 400 feet surrounded with a 6 foot embankment.
- Support services (waste treatment, landscaping, roads, utilities, etc.).

- A monitoring/surveillance program.
- A detailed operational plan.

These facilities would adequately meet the needs of the EPA Hazardous Materials Spills Control/Removal Equipment Evaluation Program and would be applicable for incorporation into other governmental agency testing programs. Site I is favored for the location of the facilities, because construction and possible operational costs are lower than for similar facilities at Sites II or III.

## SITE I IN RELATION TO SITES II AND III

Sites II and III have local surface and groundwater problems that have to be minimized before the successful establishment of a test program at either site; site preparation costs involving road construction, drainage/runoff control, and grading are expected to be more expensive than the site improvements at the Northeastern Buffer Zone site. Additionally, Sites II and III contain varied stages of forest and old field growth, which must be cleared before construction; Site I is already largely cleared of woody growth.

Reservoir design at Site I is expected to be less expensive (more varied topography and local earthen materials available) than at Sites II and III (groundwater levels should be lowered, reservoirs must be upground and larger in surface area). Establishment of a stream gradient as well as earthen dike construction will entail use of materials transported by truck from available supplies. Present costs of an average 1000 cubic foot truck load of sandy soil is estimated at $130-$140 and of clay $150. Depending on size of gradient and dimensions of channel, dikes, etc., transporting sand and/or clayey soils to Sites II and III would significantly increase construction costs, relative to Site I.

Other aspects of construction/engineering design feasibility should be clarified in the three-phase development program. Cost estimates are variable with a wide variety of factors and should be made as close to the actual implementation of the program as possible, this to eliminate cost over-runs. Preliminary estimates of the three-phase development program, as described in this section, at Sites II and III range from $640,000 to $675,000. Included in these costs are estimates for clearance of woody plants, grading, channel work, and transport of earthen fill.

# SECTION 8

# ACKNOWLEDGEMENTS

The support of this project by the Environmental Protection Agency and the Hancock County Port and Harbor Commission and the involvement exhibited by Drs. Peter B. Lederman, John E. Brugger, and Michael R. Smith are acknowledged with sincere appreciation.

Members of the project team that participated in the project work or who assisted the authors in report preparation were Messrs. T. Colpetzer, L. Mezga, D. Emerson, J. Franko, and Drs. G. Atmar, and H. Boker. Other supportive technical aid was provided by B. Johnson, C. Karr, B. Voytko, C. Kuhn, and K. Threat.

## SECTION 9

## REFERENCES CITED

(Includes citations used in Appendices)

Beranek, Leo L. 1971. Noise and Vibration Control. New York: McGraw-Hill Book Company. 650 p.

Borror, D.J. and D.M. DeLong. 1964. An Introduction to the Study of Insects (Revised Ed.). New York: Holt, Rinehart & Winston. 819 p.

Braun, E.L. 1964. Deciduous Forests of Eastern North America. New York: Hafner Publishing Company. 596 p.

Brockman, C.F. 1968. Trees of North America. New York: Golden Press. 280 p.

Brown, C.A. 1967. Mississippi Trees. Jackson, Miss.: Mississippi Forestry Commission. 96 p.

Brown, G.F., V.M. Foster, R.W. Adams, E.W. Reed, and H.D. Padgett, Jr. 1944. Geology and Ground-Water Resources of the Coastal Area in Mississippi. Miss. State Geol. Survey Bull. 60. 229 p.

Brown, L.R. 1970. Ecological Definition of the MTF Area. Mississippi State University. (Unpubl. 7-year multi-disciplinary study). [Through Johnson, 1973--Personal Communication].

Bryson, R.A. 1966. Mean Airflow and Mass Convergence Over North America (map), in J.W. MacNeill, Environmental Management. 1971. Ottawa: Information Canada. 191 p. (Original map part of Bryson's Air Masses, Streamlines and the Boreal Forest. Geog. Bull. 8(3). 1966).

Camp, Dennis W. and John W. Kaufman. 1969. Wind and Temperature Statistics for the Mississippi Test Facility Area. Bay St. Louis, Miss.: George C. Marshall Space Flight Center, Atmospheric Dynamics Branch. 40 p.

Chabreck, R.H. and A.Q. Palmisano. 1973. The Effects of Hurricane Camille on the Marshes of the Mississippi River Delta. Ecology 54(5):1118-1123.

Christmas, Y.J. 1973. Gulf Coast Research Laboratory, Ocean Springs, Mississippi. (Personal Communication).

Cook, F.A. 1959. Freshwater Fishes in Mississippi. Jackson, Miss.: Miss. Game and Fish Commission. 239 p.

Cooke, David W. 1973. Asst. Director, Gulf Coast Research Laboratory, Ocean Springs, Mississippi. (Personal Communication).

Davis, S.N. and R.J.M. DeWiest. 1966. Hydrogeology. New York: John Wiley & Sons, Inc. 463 p.

Dawson, G.W., A.J. Shuckrow, and W.H. Swift, Battelle Memorial Institute. 1970. Control of Spillage of Hazardous Polluting Substances. Water Pollution Control Research Series. 15090FOZ10/70, EPA.

Domenico, Patrick A. 1972. Concepts and Models in Groundwater Hydrology. New York: McGraw-Hill Book Company. 405 p.

Edgewood Arsenal. March, 1973. Personal interviews with staff and inspection of facilities. Edgewood Arsenal, Maryland.

Eleutarius, Lionel. 1971. Recent Changes in the Louisiana Marsh Near Vermillion Bay. Gulf Research Reports 3(2):259-263.

Eleutarius, Lionel. 1973. Botanist, Gulf Coast Research Laboratory, Ocean Springs, Mississippi. (Personal Communication).

Environmental Protection Agency. 1973. See U.S. Environmental Protection Agency, 1973.

Fernald, M.L. 1950. Gray's Manual of Botany (8th Ed.). New York: American Book Company. 1632 p.

Fisk, H.N., E. McFarlan, Jr., C.R. Kolb and L.J. Wilbert. 1954. Sedimentary Framework of the Modern Mississippi Delta. J. Sed. Petrol. 24:76-99.

Franks, J.S. et al. 1972. A Study of Nektonic and Benthic Fauna on the Shallow Gulf of Mexico Off the State of Mississippi. Gulf Research Reports 4(1):1-148.

Gleason, H.A. and A. Cronquist. 1964. The Natural Geography of Plants. New York: Columbia University Press. 174 p.

Global. 1973. See Stogner, 1973.

Grim, Ralph E. 1928. Preliminary Report on Bentonite in Mississippi. Miss. State Geol. Survey Bull. 22 p.

Gulf Regional Planning Commission. 1972. General Soils Study: Pearl River, Hancock, Harrison Counties, Mississippi. U.S. Dept. of Agriculture, Soil Conservation Service. 132 p.

Gunter, Gordon and Lionel N. Eleutarius. 1971. Some Effects of Hurricanes on the Terrestrial Biota, With Special Reference to Camille. Gulf Research Reports 3(2):283-289.

Hendry, M. 1973. Hancock County Forester, Bay St. Louis, Mississippi. (Personal Communication).

Johnson, Richard. 1973. Director, Mississippi State University Research Center at Mississippi Test Facility. (Personal Communication).

Jones, Paul H. 1968. Geochemical Hydrodynamics--A Possible Key to the Hydrology of Certain Aquifer Systems in the Northern Part of the Gulf of Mexico Basin. 23rd Intl. Geol. Congress. 17:113-125.

Kolb, C.R. 1958. Geological Investigation of the Mississippi River--Gulf Outlet Channel, Vicksburg, Mississippi. U.S. Army Corps of Engineers, Waterways Experiment Station, Miss. Paper 3-259. 11 p.

Kolb, C.R. 1962. Distribution and Engineering Significance of Sediments Bordering the Mississippi from Donaldsville to the Gulf. U.S. Army Corps of Engineers, Waterways Experiment Station. Misc. Paper 3-481.

Kolb, C.R. and J.R. Van Lopik. 1965. See Kolb and Van Lopik, 1966.

Kolb, C.R. and J.R. Van Lopik. 1966. Depositional Environments of the Mississippi River Delta Plain, Southeastern Louisiana in Deltas. Houston Geol. Soc. pp. 17-61.

Krumbein, W.C. and L.L. Sloss. 1963. Stratigraphy and Sedimentation (2nd Ed.). San Francisco: W.H. Freeman and Co. 636 p.

Lenhart, J.D. 1972. Predicting Survival of Unthinned, Oldfield Loblolly Pine Plantations. J. Forestry 70(2):754-755.

Lloyd, F.E. and S.M. Tracy. 1901. The Insular Flora of Mississippi and Louisiana. Bull. Torrey Bot. Club 28(2):61-101.

MacNeill, J.W. 1971. Environmental Management. Constitutional Study Prepared for the Government of Canada. Ottawa: Information Canada. 191 p.

McComas, M.R., John P. Kempton and Kenneth C. Hinkley. 1972. Geology, Soils and Hydrogeology of Volo Bog and Vicinity, Lake County, Illinois. Ill. State Geol. Survey, Environ. Geol. Notes 57:1-27.

McConnaughey, et al. 1970. Chemical Engineering Progress (February). p. 58. And Ten-Year Growth Patterns in the Chemical Processing Industries. Chemical Processing PRD No. 263 (1965).

McHugh, J.L. 1966. As quoted in J.S. Franks, et al. 1972. A Study of Nektonic and Benthic Fauna on the Shallow Gulf of Mexico Off the State of Mississippi.

Mellen, Frederick Francis. 1958. Cretaceous Shelf Sediments of Mississippi. Miss. State Geol. Survey Bull. 85. 112 p.

Millar, Albert E., Jr. (Ed.). 1971. Clean Water: Affluence, Influence, Effluents: A Design for Water Quality Management. ASEE-NASA Langley Research Center, Old Dominion University Research Foundation. NASA Contract NGT 47-003-028. 228 p.

Mississippi A&I. 1972. Mississippi Agricultural and Industrial Board - Mississippi. Jackson, Mississippi. 60+ p.

Mississippi Agricultural & Industrial Board. 1973 (April). Telephone Conversation and Written Communication with William Richardson, Jackson, Miss.

Mississippi River Commission. 1952. Geological Investigation of the Atchafalaya Basin and the Problem of Mississippi. Waterways Experiment Station, Vicksburg, Mississippi.

Mississippi State Highway Department. 1972. See Gulf Regional Planning Commission, 1972.

MTF Master Plan. 1970. See National Aeronautics & Space Administration, 1971.

MTF Master Plan. 1971. See National Aeronautics & Space Administration, 1971.

National Aeronautics and Space Administration. 1971. George C. Marshall Space Flight Center, 1971 Master Plan, Mississippi Test Facility. Vol. 3. 75 p.

National Aeronautics and Space Administration. 1972a. Environmental Statement for George C. Marshall Space Flight Center and Mississippi Test Facility. 55 p. + photographs.

National Aeronautics and Space Administration. 1972b. The New Mississippi Test Facility. 33 p.

National Climatic Center (ESSA). 1972. Climatic Summary Data for Jackson, Bay St. Louis Weather Stations and for Mississippi. Printouts and maps, Ashville, North Carolina.

National Oceanic and Atmospheric Administration/National Weather Service. 1972. A Climatological Summary of the Mississippi Test Facility, December 1962--February, 1972. 19 p.

National Weather Service. 1972. A Climatological Summary of the Mississippi Test Facility, December 1962--February, 1972. National Oceanic and Atmospheric Administration. 19 p.

The New Mississippi Test Facility. 1972. See National Aeronautics and Space Administration, 1972b.

Newcome, R., Jr. 1965. See Newcome, 1967.

Newcome, Roy, Jr. 1967. Development of Ground-Water Supplies at Mississippi Test Facility, Hancock County, Mississippi. Geol. Survey Water-Supply Paper 1839-H. 28 p.

Priddy, Richard Randall. 1955. Fresh Water Strata of Mississippi as Revealed by Electrical Log Studies. Miss. State Geol. Survey Bull. 83. 71 p.

Pullin, T. 1973. Botanist, Mississippi State University Herbarium, State College, Mississippi. (Personal Communication on 1/16/73).

Rand McNally. 1970. Road Atlas of United States, Canada, Mexico. 42nd Annual Edition. Rand McNally and Company, New York. 115 p.

Reisig, G.H.R. 1965. Ground Test at Marshall Space Flight Center. Research Achievements Review Series No. 9, NASA. TMX-53486. Research and Development Operations, George Marshall Space Flight Center, Huntsville, Alabama.

Rhyne, J. 1973. MTF Meteorological Station, Mississippi Test Facility. (Personal Communication).

Richmond, E.A. 1962. The Fauna and Flora of Horn Island, Mississippi. Gulf Research Reports 1(2):59-106.

Richmond, E.A. 1968. A Supplement to the Fauna and Flora of Horn Island, Mississippi. Gulf Research Reports 2(3):213-256.

Russell, R.J. et al. 1936. Lower Mississippi River Delta in Reports on the Geology of Plaquemines and St. Bernard Parishes. La. Geol. Survey Bull. 8. 49 p.

Salter, C.E. 1972. What the Well-Dressed Forest Should Wear. Amer. Forests 78(11):24-27.

Shattles, D.E. and J.A. Callahan. 1970. Water-Level and Water-Quality Trends in Aquifers Along the Mississippi Gulf Coast. U.S. Geol. Survey, Water Resources Div. Bull. 70-1. 25 p.

Stogner, J. 1972. Global General Engineering File and Data Center (Global and GE data, sheets, maps, etc.). Mississippi Test Facility, Bay St. Louis, Mississippi. (Personal Communication).

Thomas, C. and J. Miller. 1970. Plants of Davis Bayou, Ship Island, and Surrounding Areas (plus notes). Marine Biology Facility, Biology Department, Bowling Green State University, Bowling Green, Ohio. [Unpubl. listing]. 5 p. + selected herbarium sheets.

Trewartha, Glenn T. 1954. An Introduction to Climate. New York: McGraw-Hill Book Company. 395 p.

U.S. Army Corps of Engineers. 1963. Analysis for Seepage Control and Settlement for Main Canal, Mississippi Test Facility. Savannah District.

U.S. Army Corps of Engineers. 1965. Land Management Plan--NASA-Mississippi Test Operations. Mobile, Ala. pp. 1-38 (Forest Management Plan--Annex I); and pp. 1-20 (Land Management Plan).

U.S. Census. 1971. See U.S. Department of Commerce, 1971.

U.S. Coast Guard. 1970 (October). Control of Hazardous Pollution Substances. 1 p.

U.S. Coast Guard. 1971. In The Third Annual Report of the Council on Environmental Quality, August 1972. p. 120. Government Stock No. 4111-0011. Washington, D.C.

U.S. Department of Agriculture. 1930. Soil Survey of Hancock County, Mississippi. Series No. 4.

U.S. Department of Agriculture. 1970. Hancock County Soil Survey. 132 p.

U.S. Department of Agriculture, Soil Conservation Service et al. 1972. See Gulf Regional Planning Commission, 1972.

U.S. Department of Commerce. 1971. 1970 U.S. Census. Bureau of Census, Washington, D.C.

U.S. Department of Transportation. 1973. Telephone Communication--unpublished data. (May, 1973).

U.S. Environmental Protection Agency. 1973. Contract and Grant Information Sheets for Hazardous Materials Spills Research, September 1973. Washington, D.C. 33 p.

U.S. Geodetic Survey. 1972. Soundings Maps for the Northern Shoreline Areas of the Gulf of Mexico. Maps: C&GS 1265, 1266, 1267, 1268 and 1269. U.S. Coast and Geodetic Survey. Washington, D.C. [5 maps].

U.S. Geological Survey. (no date). Gulf Coast Hydroscience Center: Background Information. Water Resources Div., Mississippi Test Facility. 10 p.

U.S. Geological Survey. 1970a. Environmental Conditions and Resources of Southwestern Mississippi. Washington, D.C.: U.S. Dept. of Interior, Geographic Applications Program. 58 p.

U.S. Geological Survey. 1970b. Water Resources Data for Mississippi: Part 1, Surface Water Records; Part 2, Water Quality Records. 187 p.

U.S. Geological Survey. 1970c. Topographic Maps [7] Series V885 (Haaswood, La. - Mississippi Quadrangle) and Series V843 (Waveland, Dead Tiger Creek, Picayune, Kiln, Logtown, and Nicholson: Mississippi Quadrangles). AMS: 3045 II, 3044 I NW, 3044 I SW, 3044 I SE, 3044 I NE, 3144 IV SW, and 3144 IV NW. U.S. Department of Interior, Washington, D.C.

Van Eysinga, F.W.B. 1971. Geological Time Table. Amsterdam, The Netherlands: Elsevier Publishing Company.

Wiegert, R.G. and C.D. Monk. 1972. Litter Production and Energy Accumulation in Three Plantations of Longleaf Pine (Pinus palustris Mill.). Ecology 53(5):949-953.

Wolverton, William. 1973. Coordinator of EPA-NASA Research at the Mississippi Test Facility. (Personal Communication).

Woodlansi, J. 1973. Animal Ecologist, Gulf Coast Research Laboratory, Ocean Springs, Mississippi. (Personal Communication).

# SECTION 10

## SELECTED BIBLIOGRAPHY

(Includes references used for Appendices)

Allan, P.F. 1956. A System for Evaluating Coastal Marshes as Duck Winter Range. J. Wildl. Mgmt. 20(3):247-252.

American Geological Institute. 1962. Dictionary of Geological Terms. Garden City, New York: Dolphin Books, Doubleday and Co., Inc. 545 p.

Ashley, George H. et al. 1933. Classification and Nomenclature of Rock Units. Bull. Geol. Soc. Amer. 44:423-459.

Bennett, Carl L., Jr. 1965. Contribution Toward a Bibliography on Vegetation Survey Methods. Mich. Dept. of Con. Res. & Dev. Report No. 48. 5 p.

Berry, Charles R. 1961. White Pine Emergence Tipburn--A Physiogenic Disturbance. U.S. Department of Agriculture, Forest Service Station Paper #130. 8 p.

Berry, Edward W. 1917. The Delta Character of the Tuscaloosa Formation. Johns Hopkins University Circ., New Ser. No. 3:18-24.

Brown, C.A. 1945. Louisiana Trees and Shrubs. La. Forestry Comm. Bull. 1.

Brown, Glen F. and Robert W. Adams. 1943. Geology and Groundwater Supply at Camp McCain. Miss. State Geol. Survey Bull. 55.

Buzzell, J.C., R.H.F. Young, and D.W. Ryckman. 1968 (April). Behavior of Organic Chemicals in the Aquatic Environment, Part II: Behavior in Dilute Systems. Manufacturing Chemists Association.

Byrne, John V., Duane O. Leroy and Charles M. Riley. 1959. The Chenier Plain and Its Stratigraphy, Southwestern Louisiana. Trans. Gulf Coast Assoc. of Geol. Soc., Vol. 9. 23 p.

Colby, Bruce R. 1963. Fluvial Sediments--A Summary of Source, Transportation, Deposition, and Measurement of Sediment Discharge. Geol. Survey Bull. 1181-A. 47 p.

Coleman, J.M. and S.M. Gagliano. 1964. Cyclic Sedimentation in the Mississippi River Deltaic Plain. Gulf Coast Assoc. Geol. Soc. Trans, Vol. 14: 67-80.

Computing and Software, Inc. Slidell Computer Complex Facilities and Capabilities. 1972 (December).

Control of Hazardous Material Spills. Proceedings of the 1972 National Conference on Control of Hazardous Material Spills, Houston, Texas (March 21-23, 1972).

Cook, A.H. and C.F. Powers. 1958. Early Biochemical Changes in the Soils and Waters of Artificially Created Marshes in New York. N.Y. Fish and Game Journal.

Crider, Albert F. and L.C. Johnson. 1906. Summary of the Underground Water Resources of Mississippi. U.S. Geol. Survey Water-Supply Paper 159.

Dapples, E.C., W.C. Krumbein, and L.L. Sloss. 1948. Tectonic Control of Lithologic Associations. Amer. Assoc. Petrol. Geol. Bull. 32(10):1924-1947.

Darley, E.F., W.M. Dugger, J.B. Mudd, L. Ordin, O.C. Taylor and E.R. Stephens. 1963. Plant Damage by Pollution Derived from Automobiles. Arch. Env. Health 6:761-770.

Duffer, William R., Curtis C. Harlin, Jr., and Robert S. Kerr. 1971. Changes in Water Quality Resulting from Impoundment. U.S. EPA Project #16080. 110 p.

Envirogenics Company. 1970 (November). A Feasibility Analysis of Incinerator Systems for Restoration of Oil Contaminated Beaches. Water Pollution Control Research Series, 15080 DXE 11/70, EPA.

Fasset, Norman C. 1966. A Manual of Aquatic Plants. Univ. of Wisconsin Press. 405 p.

Federal Inter-Agency River Basin Commission. 1949. Inventory of Published and Unpublished Sediment-Load Data in the U.S. Subcommittee on Sedimentation Bull. 1. 82 p.

Federal Inter-Agency River Basin Commission. 1952a. The Design of Improved Types of Suspended Sediment Samplers, in A Study of Methods Used in Measurement and Analysis of Sediment Loads in Streams. Report 6. 103 p.

Federal Inter-Agency River Basin Commission. 1952b. Inventory of Published and Unpublished Sediment-Load Data in the U.S. Subcommittee on Sedimentation, Supp. 1946-1950. Bull. 4. 49 p.

Federal Water Pollution Control Administration. 1970. Oil Tagging System Study. Prepared for Dept. of Interior by MELPAR, Environmental and Applied Science Center, Research Div. 116 p.

Fisk, H.N. 1938. Geology of Grand and LaSalle Parishes, La. La. Geol. Survey Bull. 10. 246 p.

Fisk, H.N. 1944. Geological Investigation of the Alluvial Valley of the Lower Mississippi River. U.S. Army Corps of Engineers, Mississippi River Commission, Vicksburg, Miss.

Fleece, J.B. 1962. Carbonate Geochemistry and Sedimentology of Florida. Florida State Univ., M.S. Thesis. 112 p.

Ford, Thomas R. (Ed.). 1962. The Southern Appalachians: A Survey. Lexington, Kentucky: Univ. of Kentucky Press.

Foster, V.M. 1941. The Salt-Water Problem, Coastal Plain of Mississippi. U.S. Geol. Survey (Unpublished Memo).

Frink, J.W. 1941. Subsurface Pleistocene of Louisiana. La. Geol. Survey Bull. 19:370.

General Electric. 1964. Operation and Maintenance Manual: Potable Water System, Support Area. Bay St. Louis: Mississippi Test Support Operation. 29 p.

General Electric. 1965a. Operation and Maintenance Manual: Natural Gas System. Bay St. Louis: Mississippi Test Support Operation. 26 p.

General Electric. 1965b. Operation and Maintenance Manual: Sewerage Systems, All Areas. Bay St. Louis: Mississippi Test Support Operation. 32 p.

Gilmore, G.A., D.C. Smith, A.H. Rice, E.H. Shenton, and W.H. Moser. Dillingham Environmental Company. 1970 (February). Systems Study of Oil Spill Cleanup Procedures, Volume 1: Analysis of Oil Spills and Control Materials; Volume 2: Industry Response Plan. Contract OS-1, Committee for Air and Water Conservation, American Petroleum Institute.

Goldschmidt, Arthur. 1963. The Development of the U.S. South. Sci. Amer. 209(3):224-232.

Goodier, J.L., J.I. Stevens, S.V. Margolin, W.V. Keary and J.R. McMahan. 1971. A.D. Little, Inc. Spill Prevention Techniques for Hazardous Polluting Substances. Oil and Hazardous Materials Program Series, OHM 7102 001, EPA (February 1971).

Gould, H.R. and J.P. Morgan. 1962. Coastal Louisiana Swamps and Marshlands. Houston Geol. Soc. Field Trip, No. 9:287-341.

Grim, Ralph Early. 1936. The Eocene Sediments of Mississippi. Miss. State Geol. Survey Bull. 30. 240 p.

Gunter, Gordon and Lionel N. Eleutarius. 1971. Some Effects of Hurricanes on the Terrestrial Biota, With Special Reference to Camille. Gulf Research Reports 3(2):283-289.

Hall, Linda C. 1968. Bibliography of Freshwater Wetlands, Ecology and Management. Wisc. Dept. Natur. Resources, Research Report No. 33.

Harrold, L.L. 1955. Evaluation of Agricultural Hydrology by Monolith Lysimeters, 1944-1955. U.S. Department of Agriculture and Ohio Agricultural Experiment Station. Tech. Bull. No. 1179. 166 p.

Harvey, E.J. and T.N. Shows. 1963. Well Records, Logs and Water Analyses, George and Jackson Counties, Mississippi. Miss. Board Water Comm. Bull. 63-1. 43 p.

Harvey, E.J., H.G. Golden and H.F. Jeffery. 1965. Water Resources of the Pascagoula Area, Mississippi. U.S. Geol. Survey Water-Supply Paper 1763. 135 p.

Heck, W.W. 1967. The Effects of Ozone on Tobacco and Pinto Bean as Conditioned by Several Ecological Factors. J. Air Poll. Control Assoc. 17(2):112-114.

Heggestad, H.E., F.R. Burleston, J.T. Middleton and E.F. Darley. 1964. Leaf Injury on Tobacco Varieties Resulting from Ozone, Ozonated Hexene-1 and Ambient Air of Metropolitan Areas. Int. J. Air-Water Poll. 8:1-10.

Hepting, G.H. 1964. Damage to Forests from Air Pollution. J. Forestry (Sept. 1964):630-634.

Hill, A.C., M.R. Pack, M. Treshow, R.J. Downs and L.G. Transtrum. 1961. Plant Injury Induced by Ozone. Phytopathology 51:356-363.

Hu, Shih-Chang and Norwin E. Linnartz. 1972. Variations in Oxygen Content of Forest Soils Under Mature Loblolly Pine Stands. LSU Agric. Exper. Station Bull. 668. 27 p.

Huffman, Edward T., Charles A. Bay, and Richard Pascucci. 1968. Autometric Operation, Raytheon Co. Report No. OEPR-3311, Prepared under Contract 14-08-0001-11505 with the U.S. Geological Survey Geographical Applications Program and NASA Earth Resources Program for Office of Emergency Preparedness. 52 p.

Jacob, C.E. 1946. Drawdown Test to Determine Effective Radius of Artesian Well. Proc. Amer. Soc. Civil Engrs. 72(5).

Jones, Paul H. 1969. Hydrodynamics of Geopressure in the Northern Gulf of Mexico Basin. J. Petrol. Tech. (July, 1969):803-810.

Jones, Paul H. 1970. Geothermal Resources of the Northern Gulf of Mexico Basin. UN Symposium on the Development and Utilization of Geothermal Resources (Pisa, Italy). 22 p.

Jones, P.H., E.L. Hendricks and B. Irelan. 1956. Water Resources of Southwest Louisiana. Geol. Survey Water-Supply Paper 1364. 460 p.

Kadlec, John A. 1962. The Effects of a Drawdown on a Water-Fowl Impoundment. Ecology 43(2):267-281.

Kazmann, R.G. 1970. The Present and Future Ground-Water Supply of the Baton Rouge Area. La. State Univ., La. Water Resources Research Inst. Bull. 5.

Knight, R.C. and J.H. Priestly. 1914. The Respiration of Plants Under Various Electrical Conditions. Annual Bot. (London) 28:135-161.

Kolb, C.R. and J.R. Van Lopik. 1958. Geology of the Mississippi River Deltaic Plain, Southeastern Louisiana. U.S. Army Corps of Engineers, Waterways Experiment Station. Tech. Report No. 3-483.

Krull, John N. 1969. Seasonal Occurrence of Macroinvertebrates in a Greentree Reservoir. N.Y. Fish and Game Journal 16(1):119-124.

Krull, John N. 1970. Aquatic Plant-Macroinvertebrate Associations and Waterfowl. J. Wildl. Mgmt. 34(4):707-718.

Kummel, Bernhard. 1961. History of the Earth, An Introduction to Historical Geology. San Francisco: W.H. Freeman and Company. 591 p.

Lang, Joseph W. 1967. Geohydrologic Summary of the Pearl River Basin. U.S. Geol. Survey, Water Resources Div. and Dept. of the Army Corps of Engineers, Mobile District. 44 p.

Lang, Joseph W. and Roy Newcome, Jr. 1964. Status of salt-water encroachment in aquifers along the Mississippi Gulf Coast--1964. Miss. Board Water Comm. Bull. 64-5. 17 p.

Lea, M.C. 1964. On the influence of ozone and other chemical agents on germination and vegetation. Amer. J. Sci. Arts 37:373-376.

Linde, Arlyn F. 1969. Techniques for Wetland Management. Madison, Wisc.: Dept. of Natural Resources. Research Report No. 45. 156 p.

Linzon, S.N. 1966. Damage to Eastern White Pine by Sulfur Dioxide, Semimature-Tissue Needle Blight, and Ozone. J. Air Poll. Control Assoc. 16(3):140-144.

Livingstone, Daniel A. 1963. Chemical Composition of Rivers and Lakes, Chap. G of Data of Geochemistry. Geol. Survey Prof. Paper 440-G. 64 p.

Lohman, Shepard W. 1949. Sedimentary Facies in Gulf Coast. Bull. Amer. Assoc. Petrol Geol. 33(12):1939-1949.

Lohman, S.W. 1972. Definitions of Selected Ground-Water Terms--Revisions and Conceptual Refinements. Geol. Survey Water-Supply Paper 1988. 21 p.

Marbut, C.F. 1928. Soil Survey of Harrison County, Mississippi. U.S. Department of Agriculture, Bureau of Chem. and Soils. Series 1924, No. 7:12-13.

McGlothlin, Thomas. 1944. General Geology of Mississippi. Bull. Amer. Assoc. Petrol. Geol. 28(1):29-62.

Meinzer, Oscar E. 1923. Outline of Ground-Water Hydrology, With Definitions. U.S. Geol. Survey Water-Supply Paper 494. 71 p.

Miller, P.R., J.R. Parmeter, Jr., O.C. Taylor, and E.A. Cardiff. 1963. Ozone Injury to the Foliage of Pinus ponderosa. Phytopathology 53:1072-1076.

Mississippi Agricultural & Industrial Board. (no date). Mississippi. Jackson, Mississippi. 60+ p.

Mississippi Test Facility, Public Affairs Office. 1969. MTF/NASA Facts. Mississippi Monitor, 9th Ed.

Mississippi Test Facility. (no date). The New Mississippi Test Facility.

Monroe, Watson, H. 1947. Stratigraphy of Outcropping Cretaceous Beds of Southeastern States. Bull. Amer. Assoc. Petrol. Geol. 31(10):1817-1824.

Morse, William C. 1930. Paleozoic Rocks. Miss. State Geol. Survey Bull. 23.

Moyle, John B. 1945. Some Chemical Factors Influencing the Distribution of Aquatic Plants in Minnesota. Amer. Midland Natur. 34(2):402-420.

Moyle, John B. 1949. Some Indices of Lake Productivity. Trans. Amer. Fisheries Soc. 76:322-334.

Moyle, John B. 1956. Relationships Between the Chemistry of Minnesota Surface Waters and Wildlife Management. J. Wildl. Mgmt. 20(3):303-320.

Murray, G.F. and P.E. Thomas. 1945. Midway-Wilcox Surface Stratigraphy of the Sabine Uplift, Louisiana and Texas. Amer. Assoc. Petrol. Geol. Bull. 29:45-70.

National Aeronautics and Space Administration. (no date). Mississippi Test Facility--Electronic, Instrumentation, and Materials Laboratory. 29 p.

National Aeronautics and Space Administration. 1965. Design Criteria and Construction Standards.

National Aeronautics and Space Administration. 1969. George C. Marshall Space Flight Center--Mississippi Test Facility: Component Test Facility Capabilities. Prepared by General Electric, for Mississippi Test Support Operation. Publication No. GE-MTSO-B-013. 52 p.

National Aeronautics and Space Administration. 1972. Environmental Statement for the George C. Marshall Space Flight Center and Mississippi Test Facility. 55 p. + photographs.

Newcome, Roy, Jr. and H.F. Golden. 1964. Status of Water Resources in Jackson County, Mississippi--Fiscal Year 1964. Miss. Board Water Comm. Bull. 64-3. 17 p.

Newcome, Roy, Jr., D.E. Shattles and C.P. Humphreys, Jr. 1968. Water for the Growing Needs of Harrison County, Mississippi. U.S. Geol. Survey Water-Supply Paper 1856. 106 p.

Nobel, W. 1955. Pattern of Damage Produced on Vegetation by Smog. J. Agric. Food Chem. 3:330-332.

Norris, Stanley and Richard Fidler. 1970. Availability of Groundwater From Limestone and Dolomite Aquifers in Northwest Ohio and its Relation to Geologic Structures. U.S. Geol. Survey (in preparation).

Ohio Department of Natural Resources. 1970. Ground-water for Planning in Northwest Ohio: A Study of the Carbonate Rock Aquifers. Div. of Water, Ohio Water Plan Inventory Report 22. 63 p. + tables and charts.

Parsons, Brian E. 1967. Geological Factors Influencing Recharge to the Baton Rouge Ground-Water System, With Emphasis on the Citronelle Formation. Baton Rouge, La.: Louisiana State University, M.S. Thesis. 76 p.

Parsons, D.A. 1955. Coshocton-Type Runoff Samplers. U.S. Department of Agriculture, Agric. Research Service. ARS-41-2. 9 p.

Pettijohn, F.J. 1957. Sedimentary Rocks (2nd Ed.). New York: Harper & Row. 690 p.

Price, W.A. 1947. Equilibrium of Form and Forces in Tidal Basins of Coast of Texas and Louisiana. Bull. Amer. Assoc. Petrol. Geol. 31(9).

Priddy, Richard R. 1954. Recent Mississippi Sound Sediments Compared with Some Upper Cretaceous Sediments. Gulf Coast Assoc. Geol. Soc. Trans. 4:159-168.

Proceedings: Industry-Government Seminar on Oil Spill Treating Agents. 1970 (April). American Petroleum Institute and U.S. Department of Interior. Washington, D.C.

Rainwater, F.H. 1962. Stream Composition of the Conterminous United States. U.S. Geol. Survey Hydrol. Atlas 61.

Rainwater, F.H. and L.L. Thatcher. 1960. Methods for Collection and Analysis of Water Samples. Geol. Survey Water-Supply Paper 1454. 301 p.

Rich, Saul. 1964. Ozone Damage to Plants. Ann. Rev. of Phytopathology 2: 253-266.

Richards, B.L., J.T. Middleton and W.B. Hewitt. 1958. Air Pollution with Relation to Agronomic Crops: V. Oxidant Stipple of Grape. Agron. J. 50: 559-561.

Richards, B.L., O.C. Taylor and G.F. Edmunds, Jr. 1968. Ozone Needle Mottle of Pine in Southern California. J. Air Poll. Control Assoc. 18(2):73-77.

Rorabaugh, M.I. 1953. Graphical and Theoretical Analysis of Step Drawdown Test of Artesian Well. Proc. Amer. Soc. of Civil Engrs., Vol. 79, Separate No. 362.

Russell, R.J. (no date). River and Delta Morphology. Baton Rouge, La.: Louisiana State Univ. Coastal Studies Institute. Tech. Report No. 52. 49 p.

Russell, R.J. and H.V. Howe. 1935. Cheniers of Southwestern Louisiana. Geol. Review 25:449-461.

Russell, R.J. and R.D. Russell. 1939. Mississippi River Delta Sedimentation: Recent Marine Sediments, A Symposium. Amer. Assoc. Petrol. Geol., p. 159-160.

Ryckman, D.W., A.V.S. Prabhakara Rao, and J.C. Buzzell. 1966. Behavior of Organic Chemicals in the Aquatic Environment, a Literature Critique. Manufacturing Chemists Association.

Sarma, P.B.S. et al. 1969. A Program in Urban Hydrology, Part II: An Evaluation of Rainfall-Runoff Models for Small Urbanized Watersheds and the Effect of Urbanization on Runoff. Lafayette, Ind.: Purdue Univ. Water Resources Center. 241 p.

Scruton, P.C. (no date). Delta Building and the Deltaic Sequence. 20 p.

Scruton, P.C. 1955. Sediments of the Eastern Mississippi Delta. Soc. of Econ. Paleontol. and Mineral. Special Publication.

Sculthorpe, C.D. 1970. The Biology of Aquatic Vascular Plants. London: Spottiswoode, Ballantype and Co., Ltd. 610 p.

Semat, Henry. 1965. Fundamentals of Physics (4th Ed.). New York: Holt, Rinehart and Winston, Inc. 753 p.

Shattles, D.E., J.A. Callahan and W.L. Broussard. 1967. Water Use and Development in Jackson County, Mississippi--1964-1967. Miss. Board of Water Comm. Bull. 67-3. 23 p.

Shepard, Francis P. 1956. Marginal Sediments of Mississippi Delta. Bull. Amer. Assoc. Petrol. Geol. 40(11).

Sloss, L.L. 1964. Tectonic Cycles of the North American Craton, Symposium, Vol. II. State Geol. Survey of Kansas, Cyclic Sedimentation Bull. 169: 381-636.

Smith, Charles G. 1969. Geohydrology of the Shallow Aquifers of Baton Rouge, Louisiana. Baton Rouge, La.: Louisiana State Univ., M.S. Thesis. 32 p.

Stephens, E.R. 1969. Chemistry of Atmospheric Oxidants. J. Air Poll. Control Assoc. 19(3):181-185.

Stephenson, Lloyd W. 1914. Cretaceous Deposits of the Eastern Gulf Region. U.S. Geol. Survey Prof. Paper 81.

Stephenson, L.W., W.N. Logan and G.A. Waring. 1928. The Groundwater Resources of Mississippi. U.S. Geol. Survey Water-Supply Paper 576. 233 p.

Sternitzke, Herbert S. 1972. Bald Cypress: Endangered or Expanding Species? Econ. Bot. 26(2):130-134.

Stewart, Robert E. and Harold A. Kantrud. 1971. Classification of Natural Ponds and Lakes in the Glaciated Prairie Region. Washington, D.C.: Bureau of Sport Fisheries and Wildlife. Resource Publ. 92. 57 p.

Stewart, Robert E. and Harold A. Kantrud. 1972. Vegetation of Prairie Potholes, North Dakota, in Relation to Quality of Water and Other Environmental Factors. U.S. Bureau of Sport Fisheries and Wildlife in collaboration with U.S. Geol. Survey. Geol. Survey Prof. Paper 585-D. 36 p.

Taylor, O.C. 1968. Effects of Oxidant Air Pollutants. J. Occup. Med. 10(9): 485-492.

Taylor, O.C. 1969. Importance of Peroxyacetyl Nitrate (PAN) as a Phytotoxic Air Pollutant. J. Air Poll. Control Assoc. 19(5):347-351.

Terzahi, Karl and Ralph B. Peack. 1948. Soil Mechanics in Engineering Practice (2nd Ed.). New York: John Wiley and Sons, Inc. 729 p.

Theis, C.V. 1935. The Relation Between the Lowering of Piezometric Surface and the Rate and Duration of Discharge of a Well Using Ground-Water Storage. Trans. Amer. Geophys. Union. 16th Annual Meeting, Part 2.

Treadwell, R.C. 1955. Trafficability and Navigability of Delta-Type Coasts: Trafficability and Navigability of Louisiana Coastal Marshes; Sedimentology and Ecology of Southeast Coastal Louisiana. La. State Univ., Tech. Report 6.

Treshow, M., 1970. Environment and Plant Response. New York: McGraw-Hill Book Company.

URS Research Company. 1970 (February). Preliminary Operations Planning Manual for the Restoration of Oil-Contaminated Beaches. Water Pollution Control Research Series, 15080 EOS 3/70, Fed. Water Poll. Control Admin.

U.S. Army Corps of Engineers. 1957. Beach Erosion Board, Preliminary Analysis of Data, Mississippi River-Gulf Outlet. Washington, D.C. 22 p.

U.S. Army Corps of Engineers. 1963. Pavement and Storm Drainage Design Analysis for Main Canal, Mississippi Test Facility.

U.S. Army Corps of Engineers. 1965a. Operation and Maintenance Manual: I, Navigation Lock. Mississippi Test Facility.

U.S. Army Corps of Engineers. 1965b. Operation and Maintenance Manual: III, Bascule Bridge. Mississippi Test Facility.

U.S. Geological Survey. (no date). Gulf Coast Hydroscience Center: Background Information. Water Resources Div., Mississippi Test Facility. 10 p.

U.S. Geological Survey. (no date). NASA-Mississippi Test Facility, Administration Reports 10/15/65--7/15/68. U.S. Geol. Survey Water Resources Div.

U.S. Geological Survey, Department of Interior, 1970 (February). Environmental Conditions and Resources of Southwestern Mississippi.

Van Lopik, J.R. 1955. Recent Geology and Geomorphic History of Central Louisiana. Louisiana State University. Tech. Report No. 7

Walton, W.C. 1953. The Hydraulic Properties of a Dolomite Aquifer Underlying the Village of Ada. Ohio Div. of Water. Tech. Report No. 1.

Walton, W.C. 1962. Selected Analytical Methods for Well and Aquifer Evaluation. Ill. State Water Survey Bull. 49. 81 p.

Wetzel, L.K. 1942. Methods for Determining Permeability of Water-Bearing Materials, With Special Reference to Discharging Well Methods. U.S. Geol. Survey Water-Supply Paper 887. 192 p.

Wilder, Ira and J.P. Lafornara. Control of Hazardous Material Spills in the Water Environment. Water and Sewage Works (January 1972).

Winchell, Alexander N. and Horace Winchell. 1951. Elements of Optical Mineralogy, An Introduction to Microscopic Petrography, Part II: Descriptions of Minerals (4th Ed.). New York: John Wiley and Sons, Inc. ·cc

## SUPPLEMENTAL REFERENCES USED FOR UPDATING OF TEXT

Bitterlich, Walter. 1948. Die Winkelzahlprobe. Allegemeine Forstand Holzwirtschaftlich Zeitung 59 (1/2): 4-5.

Grosenbaugh, L.R. 1952. Plotless timber estimates--new, fast, easy. J. Forestry 50: 52-37.

Johnson Division, Universal Oil Products Company, 1966. Groundwater and Wells. Edward E. Johnson, Inc., St. Paul, Minnesota. p. 89.

Todd, D.K. 1959. Groundwater Hydrology. John Wiley and Sons, Inc., New York. 336 p.

USDOT. 1974. Telephone communication with personnel in the office of Hazardous Materials of the Accident Analysis Office, Washington, D.C.

# APPENDIX A

# EXISTING FACILITIES AND ENVIRONMENTAL BASELINE CONDITIONS

## INTRODUCTION

Appendix A represents eight technical areas designed to present a description of the existing facilities, structures, utilities, services, and environmental baseline conditions of the MTF. The descriptive material is organized into a regional/sub-regional/local presentation--aimed at conditions important to the development of a program to test and demonstrate hazardous materials spills control/removal equipment.

In general, research for this unit consisted of: (1) a search for all available pertinent literature, (2) a series of on-site observations, and (3) interviews with persons possessing expertise or knowledge in various aspects pertaining to present-day conditions at the MTF. This information is presented in the following order:

| Description | Page |
|---|---|
| Baseline Aspects: Region and Area | 72 |
| Geological Aspects of the Southwestern Mississippi Area | 80 |
| Soils and Sediments of Southwestern Mississippi and the MTF Area | 86 |
| Hydrologic Aspects of Southwestern Mississippi and the MTF Area | 97 |
| Climatic and Meteorological Aspects of Southwestern Mississippi and the MTF Area | 134 |
| Terrestrial and Aquatic Biota in the MTF Area | 160 |
| MTF Facilities and Structures | 178 |
| MTF Utilities and Services | 188 |

The baseline conditions and information presented in this section were utilized for evaluation of the MTF site as (1) a unit in entirety, and (2) as means of determining the most feasible area for general development within the MTF Fee and Buffer areas. The information presented represents a summary of all available primary and secondary sources of data in the Southern Mississippi area.

Appendix A represents the expanded technical version of environmental and physical plant conditions at the MTF. Its content is technical in nature and should be used as a supportive to the shorter main body text of this report. This pertains essentially to Sections 1, 2, 4 and 6 (Conclusions, Recommendations, Summary of Evaluation of Baseline Characteristics at the MTF, and Evaluation of Three Candidate Sites at the MTF).

Additionally, Appendix A contains much of the data for interpreted information contained in latter Appendices. As an example, Appendices B, C and D use and build upon Appendix A baseline descriptions.

## BASELINE ASPECTS: REGION AND AREA

Because of its relationship to the south-central region of the United States and to the more immediate Southern Mississippi area, the MTF site possesses many attributes that commend it as a location for a potential HMSE Test Center. The MTF site is at the focal point of a large arc encompassing one of the fastest growing economic regions of the United States today. A radius extending 500 miles (the range of "next day" delivery) from the site embraces such metropolitan centers as Houston, Dallas, Memphis, Nashville, Atlanta, Jacksonville, and Tampa-St. Petersburg.

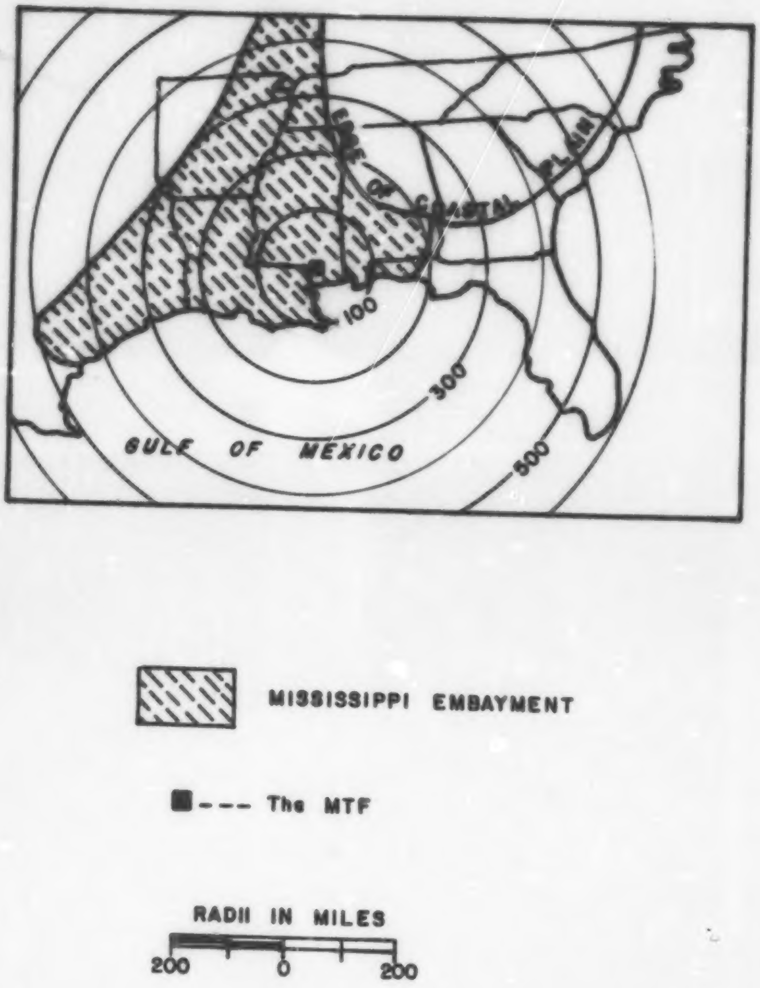
The rate of population growth within this region during the 1960's exceeded the national rate and was surpassed only by the western region of the United States. Within the south-central region, economic and cultural growth over the past decade has become legendary, with such cities as Houston and Atlanta rivaling the giants of the East, North and West as cosmopolitan centers.

Industrial and urban development has flourished throughout the region largely because of certain amenable attributes that give it competitive advantages over other regions of the country. Chief among these are its central location, diverse resources, multi-mode transportation systems, an increasingly skilled labor force, availability to construction materials, power, recreation, and a favorable climate (Ref.: Mississippi Agricultural & Industrial Board, 1973).

The Southern Mississippi area, and in particular the MTF site, are located, in effect, at the crossroads of commerce within the arc encompassing the south-central region of the United States. This strategic position, in a large measure, accounts for both the economic sustenance Southern Mississippi draws from and the contribution it makes to the region. The following pages will examine in more detail the relationship of the MTF site to the Southern United States; to a portion of the region embracing Eastern Louisiana, Southern Mississippi, and Western Alabama; and to the area immediately surrounding the MTF site.

### Regional Relationships

Favorable climate is a major factor in encouraging industrial and research-oriented development in the region. Mississippi, Louisiana, and Alabama are located in the Gulf Coastal Province (Figure 18) which has more than 200



LOCATION OF THE MTF IN SOUTHEASTERN UNITED STATES

Figure 18

growing days per year, an average annual temperature of 65°F, and an evenly distributed, average annual precipitation of 58 inches. The winters are mild, averaging 48°F, with fewer than 60 days of sub-freezing temperatures. Figure 19 illustrates climate factors of the Southeast United States.

The mild climate eliminates certain storage and construction problems commonly encountered in colder regions. Lost time and absenteeism due to severe weather are unusually rare. Transportation schedules are also rarely disrupted, and the opportunities for outdoor recreation, as a side benefit, are greatly increased.

Ease of accessibility to raw materials has facilitated a rapidly expanding industrial development in the region. The Mississippi area is rich in crude oil and natural gas. Louisiana ranks second and Mississippi eighth in production of crude petroleum. Other important raw materials include bauxite, lignite, sulfur, lime, wood products, and cotton.

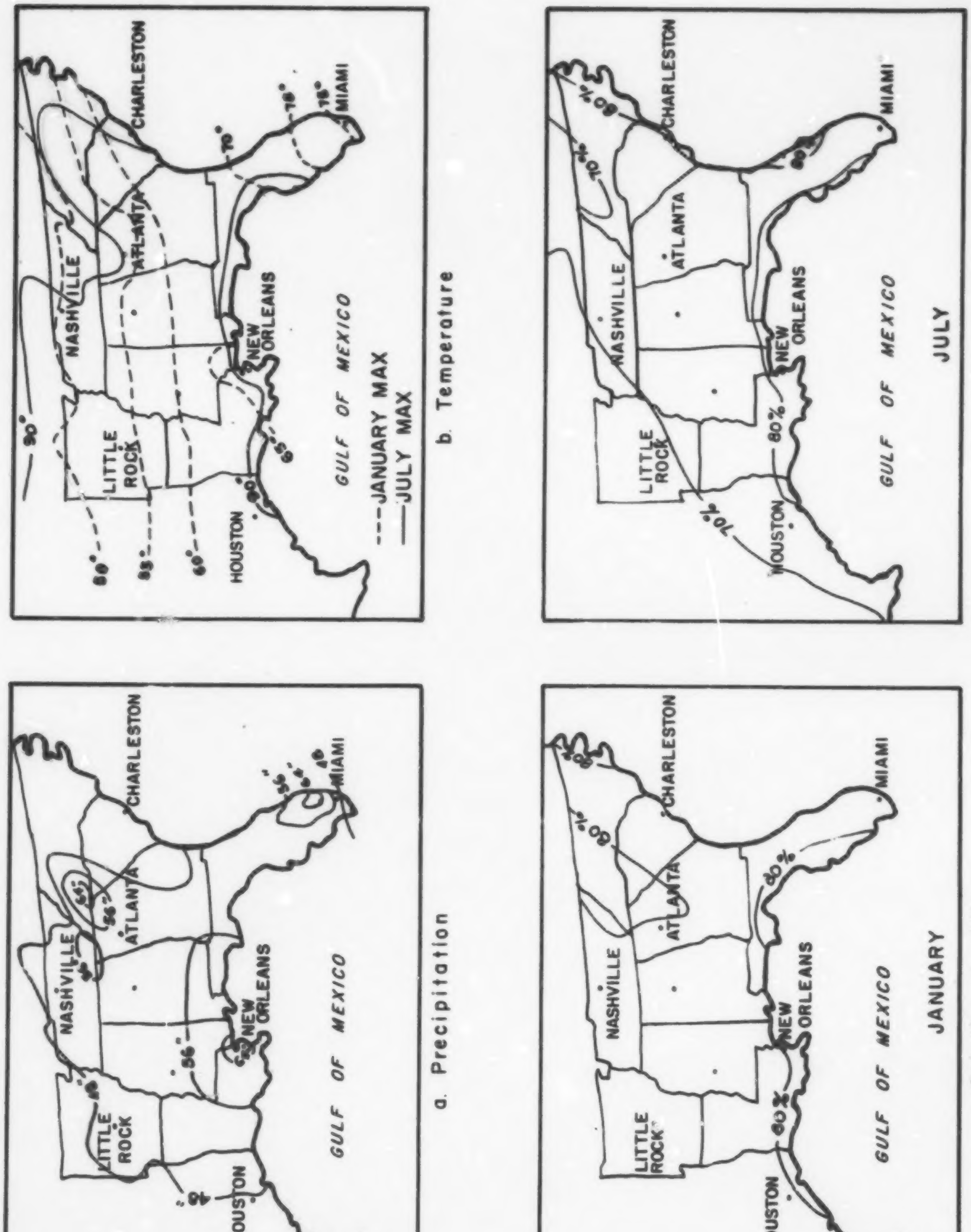
Petroleum production in the region as well as expeditious transportation from fields outside the region have fostered the development of large refining and petrochemical complexes at both Baton Rouge, Louisiana and Pascagoula, Mississippi. These, in turn, provide raw materials to feed other attendant organic and inorganic chemical industries. Organic chemical plants produce oil and gas distillates, acetate salts, formaldehyde, nylon salts, synthetic rubber, and a wide variety of plastic resins. The inorganic chemical industry produces soda ash, caustic soda, chlorine, sulfuric acid, sulfur, pesticides, herbicides, mercury compounds, nicotine compounds, fumigants, and fungicides. (Ref.: Mississippi Agricultural and Industrial Board, 1973).

The availability of such natural resources as iron and aluminum ore, magnesium, zinc, and tin has spawned a robust metallurgical industry in the region. Iron and steel are manufactured at Birmingham, Alabama; aluminum at Mobile, Alabama; Port Lavara, Texas; Baton Rouge and New Orleans (Figure 20).

Mississippi has made great strides in the past two decades to reduce its dependence on agriculture and enlarge its industrial base. As a result, manufacturing has become the leading economic activity in the state, accounting for 26 percent ($1.9 billion) of Mississippi's gross revenues. Other important segments of the state's economy are wholesale and retail trade, 15 percent; government, 15 percent; agriculture, 14 percent; services, 13 percent; construction, 6 percent; and transportation, communications, and public utilities, 6 percent (Ref.: Mississippi Agricultural and Industrial Board, 1973).

While cotton is still the major agricultural product of Mississippi--the state's production constitutes 16 percent of the United States' total--its dominance has been reduced because of unstable markets, growing labor costs, and increasing soil erosion. Livestock, dairy, poultry, grains and truck farming are important segments of the state's increasingly diversified agricultural activities. In Southern Mississippi, dairying and livestock are the major agricultural enterprises.

Southern Mississippi is also the site of a major wood products industry because of the abundance of forests there. Southern pines and hardwoods support the pulp. paper, lumber, and furniture industries of Mississippi and the surrounding region.



a. Precipitation

b. Temperature

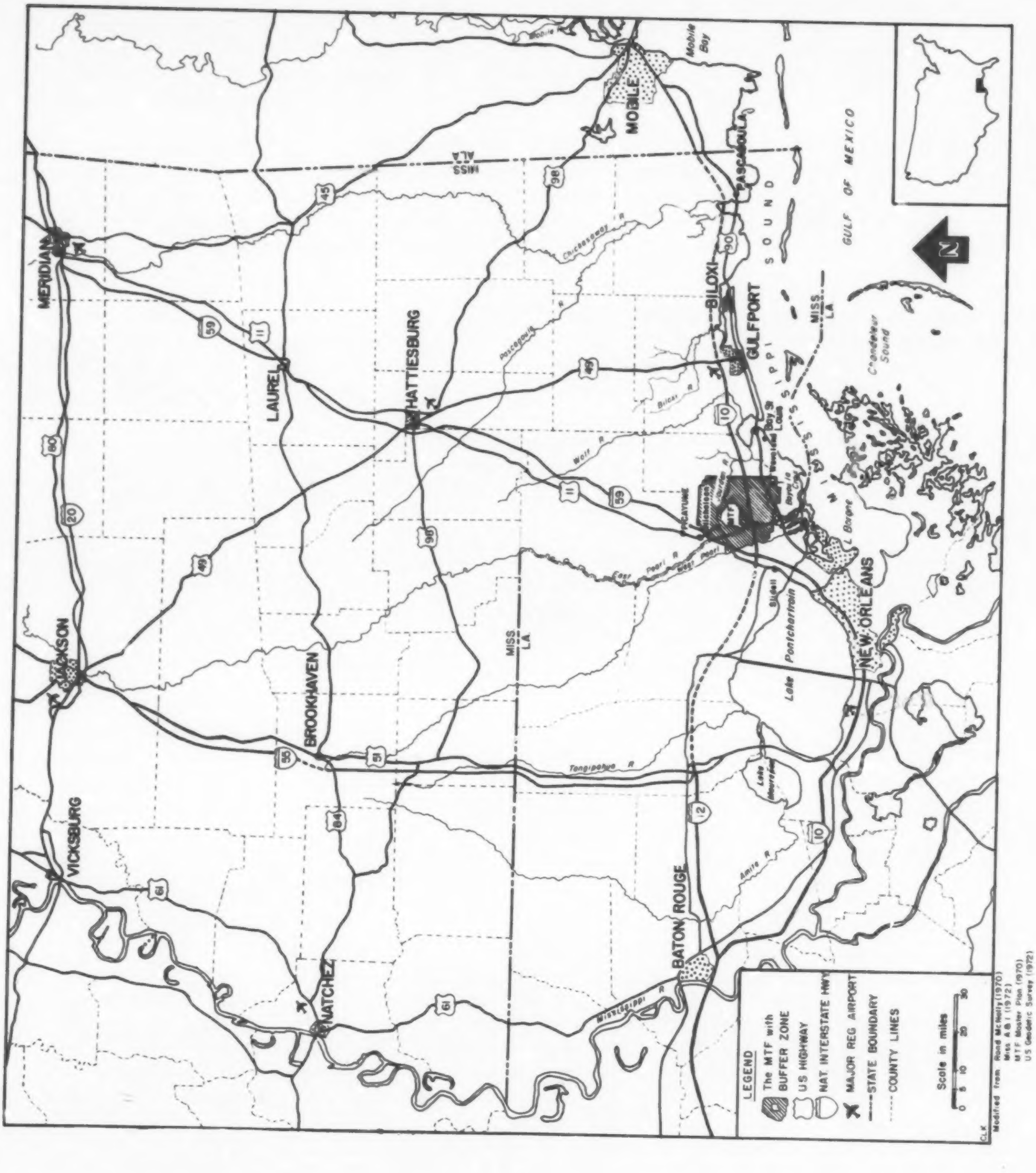
c. Relative Humidity

d Relative Humidity

Modified from National Climatic Center, 1972

CLIMATIC FACTORS IN THE SOUTHEASTERN UNITED STATES

Figure 19



Modified from Rand McNally (1970)
Miss A & I (1972)
MTF Master Plan (1970)
US Geodetic Survey (1972)

THE MISSISSIPPI TEST FACILITY AND SURROUNDING REGION

Figure 20

A fishing industry thrives along the Gulf Coast and supplies shrimp, oysters, menhaden, crabs, and red snappers to a national market. The Gulf Coast is also a primary tourist area. Mississippi's entire coast line from Bay St. Louis to Pascagoula realizes about $200 million per year solely from tourism (Ref.: Mississippi Agricultural & Industrial Board, 1973).

Transportation facilities in the region are abundant and diverse (Figure 21) with Mississippi, in particular, served by 48 truck lines, 14 railroads, 5 bus lines, 13 barge lines, 3 airlines, and several common carrier pipelines. These facilities interconnect the industrial centers and seaports of the region and, in turn, connect them to markets and distribution centers throughout the world.

Major railroads service the region and connect directly to the MTF site through such nearby cities and distribution centers as New Orleans and Baton Rouge in Louisiana; Vicksburg, Jackson, Meridian, Hattiesburg, Pascagoula, Biloxi, Gulfport and Bay St. Louis in Mississippi; and to Mobile in Alabama.

Barges and ocean-going vessels serve New Orleans; Baton Rouge; Pascagoula, Vicksburg, and Natchez, Mississippi; and Mobile, Alabama. Barge facilities in Mississippi are located at Yazoo City, Biloxi, Pass Christian, Pascagoula, Bay St. Louis, and the MTF site itself.

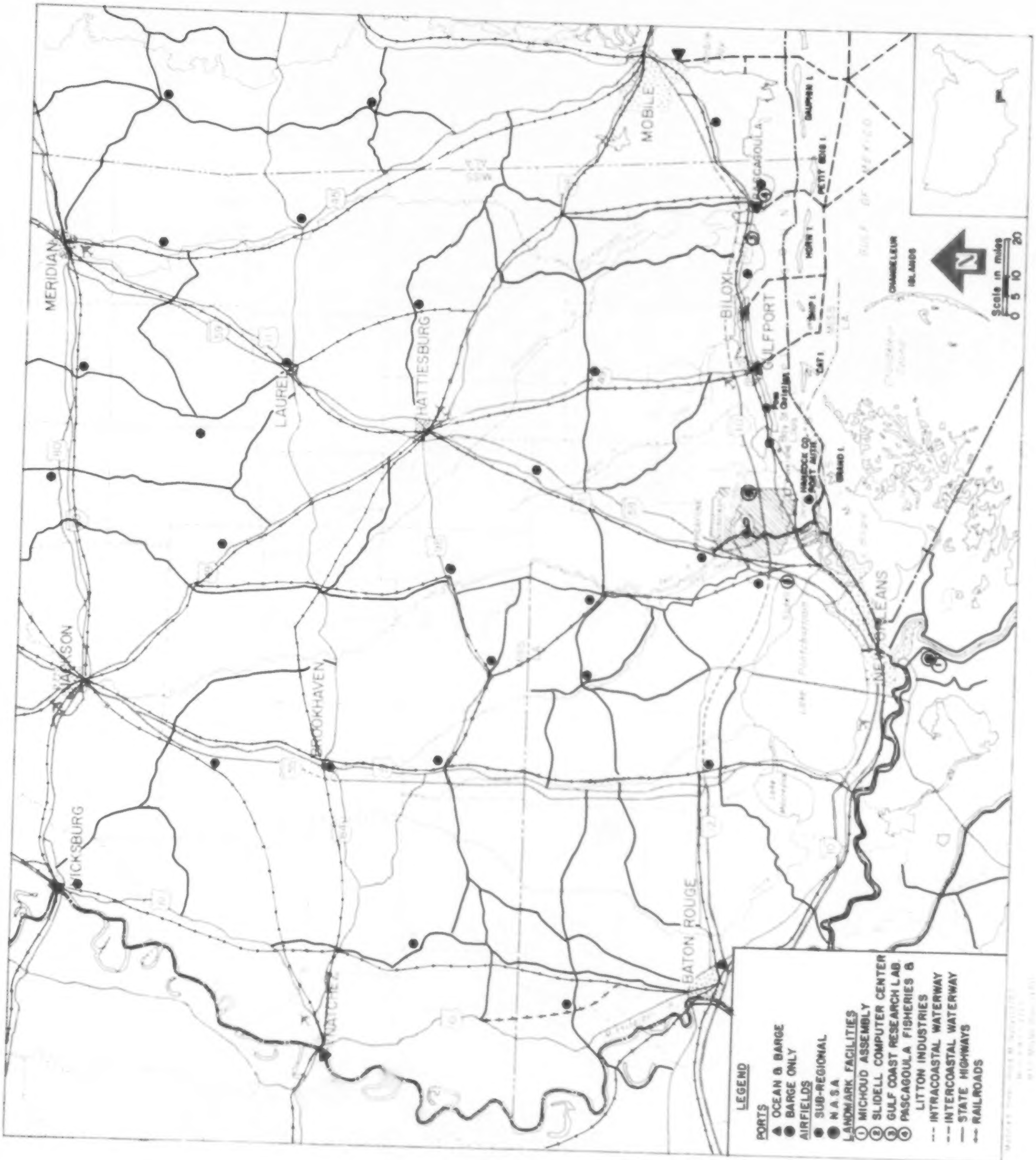
Mississippi is served primarily by three airlines: Delta, Southern Airways, and Texas International. However, these provide connections with all major trunk airline routes. In addition, the nearness of major airports at Jackson, Baton Rouge, and Mobile, and the international airport at New Orleans (served by 12 airlines), provides the MTF site with a large selection of air transportation service.

Truck terminals are located at New Orleans, Mobile, Picayune, Gulfport, Moss Point, and Pascagoula. Vehicular transportation in Mississippi is facilitated by 6,400 miles of urban highways and 60,000 miles of rural highways. Several major highways, including interstate highways, serve the Southern Mississippi area (Figure 21). Of these, the MTF site has quick and easy access to I-59 and US 49 (north-south highways) and I-10 and US 90 (east-west highways) (Ref.: Mississippi Agricultural and Industrial Board, 1973).

## Area Relationships

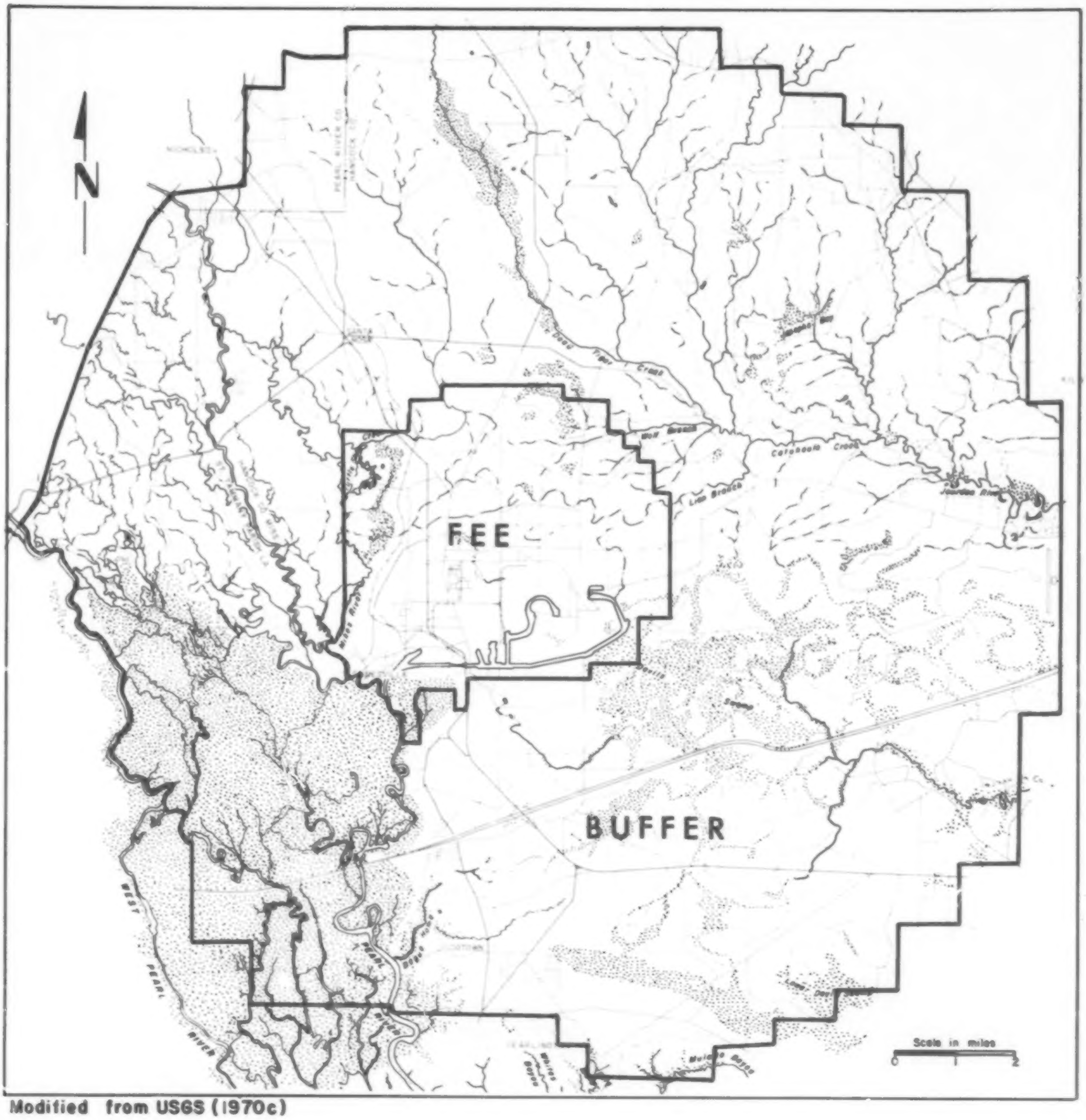
The area immediately surrounding the MTF site in Southwest Mississippi embraces Pearl River, Stone, Harrison and Hancock Counties in Mississippi and, to a lesser degree, St. Tammany, Washington, Orleans, and Tangipahoa Parishes in Louisiana (Figure 21). This covers a radius of about 50 miles from the MTF site and will be referred to as "the MTF area." The MTF Buffer and Fee areas are shown in Figure 22.

Within the MTF area is a labor force of 355,000, of which 65 percent are males, 57 percent are between the ages of 25 and 40, and 3.6 percent are unemployed. While the unemployment rate is lower than the national average, it has risen in the last few years because of cut-backs in the National Aeronautic and Space Administration's activities at the MTF.



TRANSPORTATION IN THE VICINITY OF THE MTF

Figure 21



Modified from USGS (1970c)

FEE - Central Fee Area of The MTF
BUFFER - Buffer zone that surrounds the Central Fee Area

THE MISSISSIPPI TEST FACILITY FEE AREA AND BUFFER ZONE

Figure 22

Unemployed former MTF personnel constitute a reservoir of relatively highly skilled workers. A high percentage of former MTF employees have completed 12 or more years of education while the state average is 8.5 years. In addition, a survey by the Mississippi Research and Development Center found that 2,600 graduates of the University of Mississippi who live out of state are willing to return, provided job opportunities are available. Thus, it would seem that the HMSE Test Center would have an adequate labor pool from which to draw essential skills and manpower.

During the 1960's Southwest Mississippi generally experienced a generous growth in population. Table 2 shows the population changes for cities in the vicinity of the MTF site from 1960 to 1970.

The increase in population within the MTF area has generally been attributed to an expanding economy and the recreational and tourist attractions in the area. Major golf courses, yachting, fishing and bathing, natural and historic landmarks, lodging facilities, and private and public airports offering quick access, have made the Mississippi Gulf Coast one of the major resort areas of the United States. Locally, the Gulf Coast recreational attractions have spurred construction of buildings and roads which, in turn, will stimulate increased patronage and commercial enterprise.

The MTF area is in the direct path of a developing metropolitan corridor extending from New Orleans to Mobile. The proximity of the area to these two major cities, and to Jackson, Mississippi, provides residents of the area with the cultural and commercial amenities associated with metropolitan living. In general, the MTF area is an exurb of New Orleans, and to a lesser extent, of Mobile.

In terms of area transportation, the Louisville and Nashville and the Southern Railroads have trunk lines that pass the MTF site. The Southern has a spur to the MTF. Major railway distribution centers surround the area.

In addition to air transportation service at the major cities in the region described earlier, certified commercial service is available at airports in Gulfport, Hattiesburg, Laurel, Natchez, Vicksburg, and Meridian. Airports with paved runways are also located at Picayune and Wiggins, and Stennis Airfield is located to the east of the MTF Buffer Zone. Also, there are two other private airports in the area, as well as a military airport at Keesler Air Force Base, Biloxi.

With the completion of Interstate Highways 10 and 12, the MTF site and surrounding area will have direct interstate highway connections to Baton Rouge and Mobile. The area presently has interstate highway connections to New Orleans, Vicksburg, Jackson, and Meridian. In addition, the Mississippi Legislature has approved a $600 million program that will provide a state-wide network of four-lane, limited access highways to supplement the interstate system (Ref.: Mississippi Agricultural and Industrial Board, 1973).

## GEOLOGICAL ASPECTS OF THE SOUTHWESTERN MISSISSIPPI AREA

Southern Mississippi lies on thick sediments on the eastern limb of the Mississippi embayment and dips westerly on an axis which is approximately parallel

Table 2 . PERCENTAGE CHANGE IN POPULATION IN SELECTED CITIES, 1960 to 1970[a]

| City | County | Percentage Change |
|---|---|---|
| Bay St. Louis | Hancock | + 33.1 |
| Biloxi | Harrison | + 10.1 |
| Gulfport | Harrison | + 35.1 |
| Longbeach | Harrison | + 29.4 |
| Pass Christian | Harrison | - 23.2[b] |
| Picayune | Pearl River | + 33.6 |
| Poplarville | Pearl River | + 8.6 |
| Waveland | Hancock | +181.0 |

[a] U.S. Census, 1971.

[b] Decrease thought to be the result of Hurricane Camille destruction in 1969.

to the Mississippi River. This portion of the limb in Northern Mississippi dips at a rate of 10-15 ft. per mile which increases to a rate of 40-90 ft. per mile in the south (Ref.: Mellen, 1958).

More specifically, Hancock County is located on thick Quaternary sequences of deltaic Mississippi River deposits, which in turn overlay deposits laid down during the Mesozoic and Paleozoic marine coastal environments. The coastal environment, when used in the various geohydrological studies in this section, refers to physical characteristics of four principal coastal situations involving deltaic or related deposition: (1) fresh water, (2) estuarine or brackish, (3) marine, and (4) deltaic or river-associated. The complex tectonic, volcanic and crustal histories (refers to a series of paleo-geological developmental events) also contributed significantly in terms of type, thickness, and chemistry of the lithologic units evident in the following defined geologic column (see Table 3 ). A brief description of these histories is presented in the following pages.

## Paleozoic Era

Paleozoic rocks in the State of Mississippi are buried beneath thick sequences of Mesozoic and Cenozoic sediments. Core borings and electric logs indicate the Paleozoic to be 1300-1600 ft. thick, with a dip slightly to the west. The Paleozoic deposits are made up (from older to younger) of dense Devonian limestones, limestone shales and sandstones of the Mississippian period, and Pennsylvanian shales and siltstones (Ref.: Brown, et al., 1944).

## Mesozoic Era

Regional pre-Quaternary sediments underlying the State of Mississippi are Cretaceous sediments believed to have been deposited in deltaic-coastal environments similar to those that exist today (Ref.: Priddy, 1955). The inner edge of the ancient coastal line (Mississippi Embayment) occurs in North-Eastern Mississippi and encompasses part of what is referred to as the Interior Salt Basin. Prior to depositional sequences, the Mississippi Embayment sediments had been subjected to diastrophic warping which occurred during Permian, Triassic, and possibly early Jurassic periods. This small but significant crustal flexure controlled the northern extent of the thick subsequent depositional processes which were to follow. The tectonic fringe line also exhibited control (illustrated in Figure 23 ) on the thickness and types of sediments (Ref.: Priddy, 1955).

The lower basal Cretaceous conglomerates (Comanchean sands in Mississippi) were unconformably (refers to a surface of erosion or non-deposition, usually the former, that separates younger sediments from older rocks) laid down over Paleozoic (Black Warrior Basin--Pennsylvanian sediments) rocks by transgressing seas. The "shelf deposits" of the Cretaceous seas in the Mississippi Embayment have been mapped as far north as Southern Illinois.

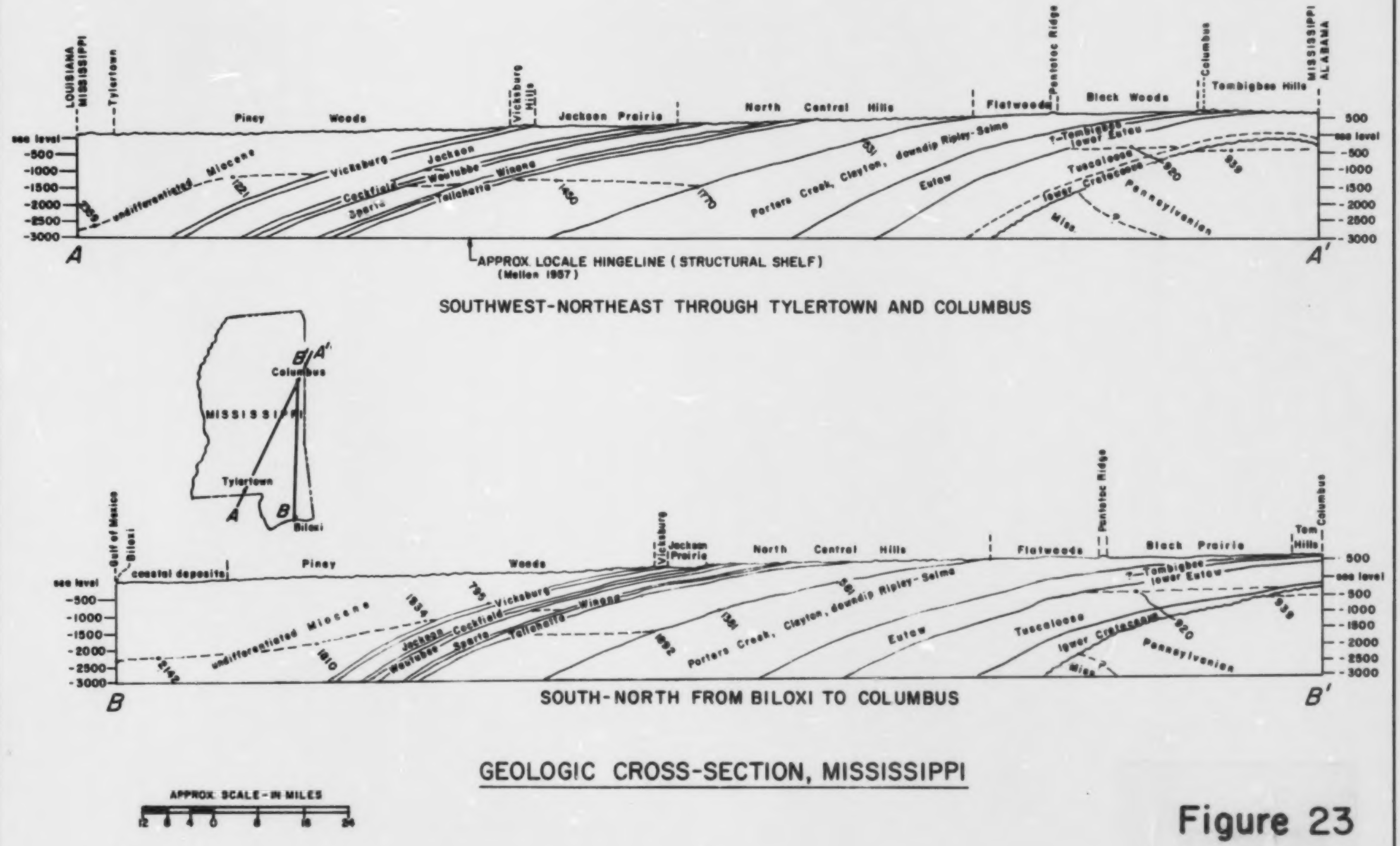
The recession of Cretaceous seas coupled with erosion and volcanic activity reworked conglomeratic Comanchean basal sands, which had been partially or wholly incorporated into clay deposits as thick sand wedges. The complex Upper-Cretaceous geological history, is, however, depicted by several off-lap and on-lap sequences. The bottom sediments in transgressive seas (on-lap)

# Table 3

## GEOLOGIC COLUMN FOR THE STATE OF MISSISSIPPI

| Approx. Years (Millions) | Era | System / Period | Series | Formation | Member | Lithology | Thickness | | Map Symbol |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Surface | Down-Dip | |
| 1 | CENOZOIC | QUATERNARY<br>Recent (Holocene)<br>Pleistocene | | Alluvium<br>Pamlico<br>Low Terrace<br>High Terrace<br>Citronelle | | | 0-35+<br>1-75<br>0-20<br>0-100<br>0-160 | | |
| 10 | | Pliocene | | Graham Ferry | | | 113-975 | | |
| 25 | | TERTIARY<br>Miocene | (Undifferentiated) | Pascagoula<br>Hattiesburg<br>Catahoula | | Silty sands, lenses of silts, clays, lignites, clean sands. | Up to 6200 | | M |
| 40 | | Oligocene | Vicksburg | Mint Springs<br>Forest Hill<br>Yazoo | | Glauconitic marly sand, silty clays & silty sandstone with a few sands. | 5-25<br>75-125 | 30<br>100 | V<br>F |
| | | Eocene | Jackson | Moodys Branch | | | | | |
| | | | Clairborne | Cockfield | Wautubbee (Cook Mt.) | River laid sands with lenses of silts clay and lignites. | 150-300 | 450 | C |
| | | | | Lisbon | Sparta (Kosciusko) | Sand with lenses of clay and silt toward the northwest. | 50-400 | 700 | S |
| | | | | | Zilpha<br>Winona | Green, glauconitic, marly, marine sand. | 15-60 | 150 | W |
| | | | | Tallahatta | Neshoba | | | | |
| | | | Wilcox | (Undifferentiated) | | Upper part mostly sand, lower part sand with silt, clay and lignite lenses. | 200-800 | 1500 | Wx |
| 60 | | Paleocene | Midway | Porters Creek<br>Clayton | | | | | |
| 70 | MESOZOIC | CRETACEOUS<br>Gulf | Gulfian | Ripley<br>Selma | Prairie Bluff<br>Owls Creek<br>McNairy<br>Chiwapa | | | | |
| | | | | Eutaw | Tombigbee | Massive, glauconitic, micaceous, marine sand. | 75-125 | Shaled Up | E |
| | | | | Tuscaloosa | | Upper succession of sands & red shales basal gravel. | 200-500 | 1500 | T |
| 270 | PALEOZOIC | PENNSYLVANIAN | | Pennsylvanian | | Shales & siltstones, a few porous sandstones, basal conglomerate. | No Outcrop | 500-4000 | P |
| 350 | | MISSISSIPPIAN | | Mississippian | | Dense limestones & shales, a few porous sandstones & limestones. | No Outcrop | 500-1500 | Ms |
| 400 | | DEVONIAN | | Devonian | | Dense limestones & shales, a few porous limestones. | | 300? | D |

SOURCE: Brown, Foster, Adams, Reed, Padgett, 1944; Priddy, 1955; Van Eysinga, 1971.



SOUTHWEST-NORTHEAST THROUGH TYLERTOWN AND COLUMBUS

SOUTH-NORTH FROM BILOXI TO COLUMBUS

GEOLOGIC CROSS-SECTION, MISSISSIPPI

Figure 23

Modified from PRIDDY (1955)

form coarse clastic facies (sands and gravels) while the regressive seas (offlap) form fine clastic facies (succession of related sediments that have different appearance or composition, which consists of fragments of rocks or of organic structures that have been moved individually from their place of origin, such as clays and silts). (Ref.: Krumbein and Sloss, 1963). Several of these sequences have formed the Tuscaloosa, the Eutaw, the Selma, and the Ripley formations of the Gulfian Series.

The Tuscaloosa formation, the oldest Cretaceous outcrop in the State of Mississippi, is predominantly a mixture of sands and red shales. Overlying the Tuscaloosa formation is the Tombigbee member of the Eutaw formation. The lower section of the Tombigbee member of the Eutaw formation is a sand/shale succession (Ref.: Priddy, 1955), while the upper section of the Tombigbee member of the Eutaw formation is a silty, glauconitic micaceous sand. A glauconitic micaceous sand is a mica-rich green (authigenic) mineral essentially a hydrous potassium, iron silicate which occurs in a marine-sedimentary environment.

The Selma formation is primarily composed of the Coffee Sand, and the Annona-Selma Chalk. The Selma formation is overlain by the Chiwapa, McNairy and Prairie Bluff-Owl Creek members of the Upper-Cretaceous Ripley formation. These formations, thicknesses, and stratigraphic locations are illustrated in Table 3 , while Figure 23 depicts the north-south cross-section of the thick sediments in the Mississippi Embayment.

## Cenozoic Era

The thick Cenozoic sedimentary units in the down-warped Mississippi Geosyncline (Ref.: Priddy, 1955) which overlie the Cretaceous bedrock are Tertiary and Quaternary deltaic deposits. The oldest series (Midway-Paleocene System) in the Tertiary underlies thick Eocene sand, silts, and clay sediments. Eocene deposits have been subdivided into the Wilcox Series (Lower Eocene), the Tallahatta, the Lisbon, and the Cockfield formations (Mid-Eocene), and the Jackson Series (Upper Eocene). The Oligocene-Vicksburg Series is a thin, glauconitic marly (clayey, calcareous sediments) sand which separates the Eocene from thick Miocene sediments. The Miocene strata, where they outcrop, reveal that most of the sediments were deposited in non-marine coastal environments. These sediments are comprised of silty-clayey lenses towards the strand line (beach) and grade into pure sand lenses downdip (seaward).

The Pliocene (Upper-Tertiary), as well as the sediments of the Pleistocene, and Recent sediments are partially undifferentiated deltaic deposits. These units represent the complex sedimentary geosynclinal history which had taken place in the last 70 million years (Ref.: Van Eysinga, 1971).

The lower Miocene coarse base of the estuarine and deltaic sequences are comprised of the Catahoula sandstones. The Hattiesburg formation deposited on the flanks of the Wiggens-Lucedale anticline is a Mid-Miocene deposit of mixed marine/non-marine shales, sands, and silts. The Pascagoula (Upper Miocene) formation is an interval above the Hattiesburg formation, formed from silts, clays, and shales.

The Pliocene deposits are referred to as belonging to the Graham Ferry formation, a marine/non-marine series of deposits of heterogeneous deltaic sands, clays and silts which underlie the more recent Pleistocene sediments. The

Pliocene-Citronelle formation rests disconformably over the lower formation and remains in many places as terraces. The literature indicates that this formation may be Pleistocene in age. (The term disconformably refers to an unconformity separating essentially parallel beds.) The Citronelle formation is comprised predominantly of sands and gravels varying in texture as a result of redeposited and reworked sediments of the much older Upper Miocene Pascagoula formation. Pleistocene sediments lying above the Citronelle formation are comprised of two thin units referred to as the High and the Low Terrace. Above these two terrace units lies the thicker Pamlico sand unit. The Pamlico unit forms many of the white, sandy beaches and barrier islands featured along the coast of the Mississippi Sound.

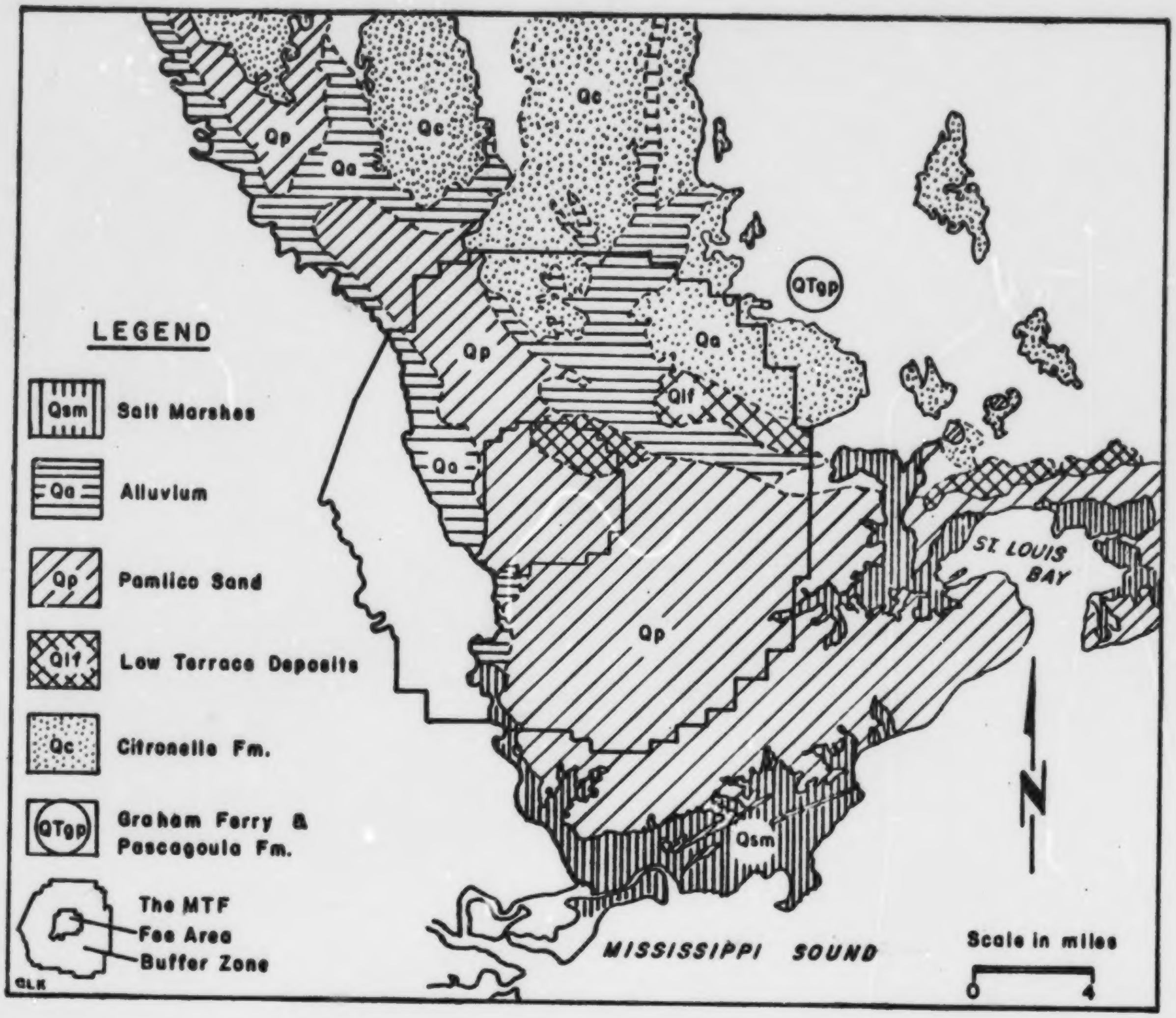
The sandy inland outcrops of the Citronelle formation (Pliocene) are believed to serve as the principal recharge zones for partially confined shallow aquifers underlying the MTF. These partially confined sands coupled with complex faulting are believed to partially account for the high hydrostatic pressures recorded in the MTF drilled wells (Ref.: Jones, 1968).

Lastly, the Holocene or Recent deposits are undifferentiated, highly variable deltaic deposits composed of silts, clays, sand, mucks and peats. These heterogeneous sediments comprise the surface deposits of the MTF and will be described in detail in the following sections. (Figure 24 illustrates Pleistocene to Recent deposits in Southwest Mississippi).

## SOILS AND SEDIMENTS OF SOUTHWESTERN MISSISSIPPI AND THE MTF AREA

Present-day geologic coastal environments in the vicinity of the MTF are comprised of various sediments deposited during the Miocene period to the present. Partially-undifferentiated deposits were laid down in the Mississippi Geosyncline as previously described in the estuary and deltaic coastal environments. These deposits along with periodic subsidence of the St. Bernard-Metairie-Gentilly subdelta (Ref.: Russell, 1936) of the Mississippi deltaic complex have produced the present-day coastal environments in the vicinity of Harrison and Hancock Counties. In the Hancock County coastal area either a rise in sea level or a series of local sediment subsidences have partially obliterated surface deltaic topographic features. Definition of these sediments, at least in the vicinities of the Pearl River in Hancock County, have been made (Ref.: Priddy, 1955) and include: (1) fluvial (stream origin), (2) fluvial-marine (pro-delta), (3) paludal (swamp), and (4) marine (beach bar-sand) environments. Further definition of these coastal environments will be presented later in this section.

The soils in Southwest Mississippi were formed during the last recession of saline water from the thick deltaic deposits on the shallow Gulf Coastal plain. In general, the soils range from light, moderately-drained, sandy soils to poorly-drained, clayey soils. The characteristics of these soils are a function of local topography, vegetation, parent materials, and climate (Ref.: McComas, Hinkley & Kempton, 1972). Sandy soils are located on topographic highs which were probably deposited on pre-Pleistocene strand (beach) lines. Clayey soils were probably formed from remnants of old mudflats or were locally formed by their relative position to low-lying discharge zones.



QUATERNARY SEDIMENTS IN SOUTHWEST MISSISSIPPI

Figure 24

Soils in Hancock County, and in particular the MTF area, are comprised of clayey silts, fat (organic) clays, lean (non-organic) clays, and inorganic and organic silts, with isolated lenses of sands and silty sands. The percolation values of 1-in. samples at random locations in the MTF Buffer and Fee Areas generally ranged from a time period of 43 to 145 minutes. These and the canal seepage rates were calculated by the U.S. Army Corps of Engineers, Savannah, Georgia (1963), with the seepage values as follows:

| Soil Types For Engineering Unified Soil Classification | Average Thickness | Hydraulic Conductivities |
|---|---|---|
| SM, ML | 33 ft. | 0.15 ft./min. |
| Sm | 26 ft. | 0.17 ft./min. |
| Sm, SP | 22 ft. - 38 ft. | 103 ft./min. |

These seepage rates in the MTF canal system indicate that permeability characteristics vary according to soil characteristics. In order to classify these soil groups more accurately, a detailed survey program should be instigated to define the various soil properties. These soils are saturated continuously because of high water tables (e.g. several low-lying areas such as Devil's Swamp [located to the immediate southeast of the MTF Fee Area] have stream gradients so low that naturally occurring and easily recognized channel development does not exist in most cases). Soil classification in the MTF Buffer and Fee Areas has also been defined by the U.S. Department of Agriculture (1930 and 1970, see Figures 25 and 26).

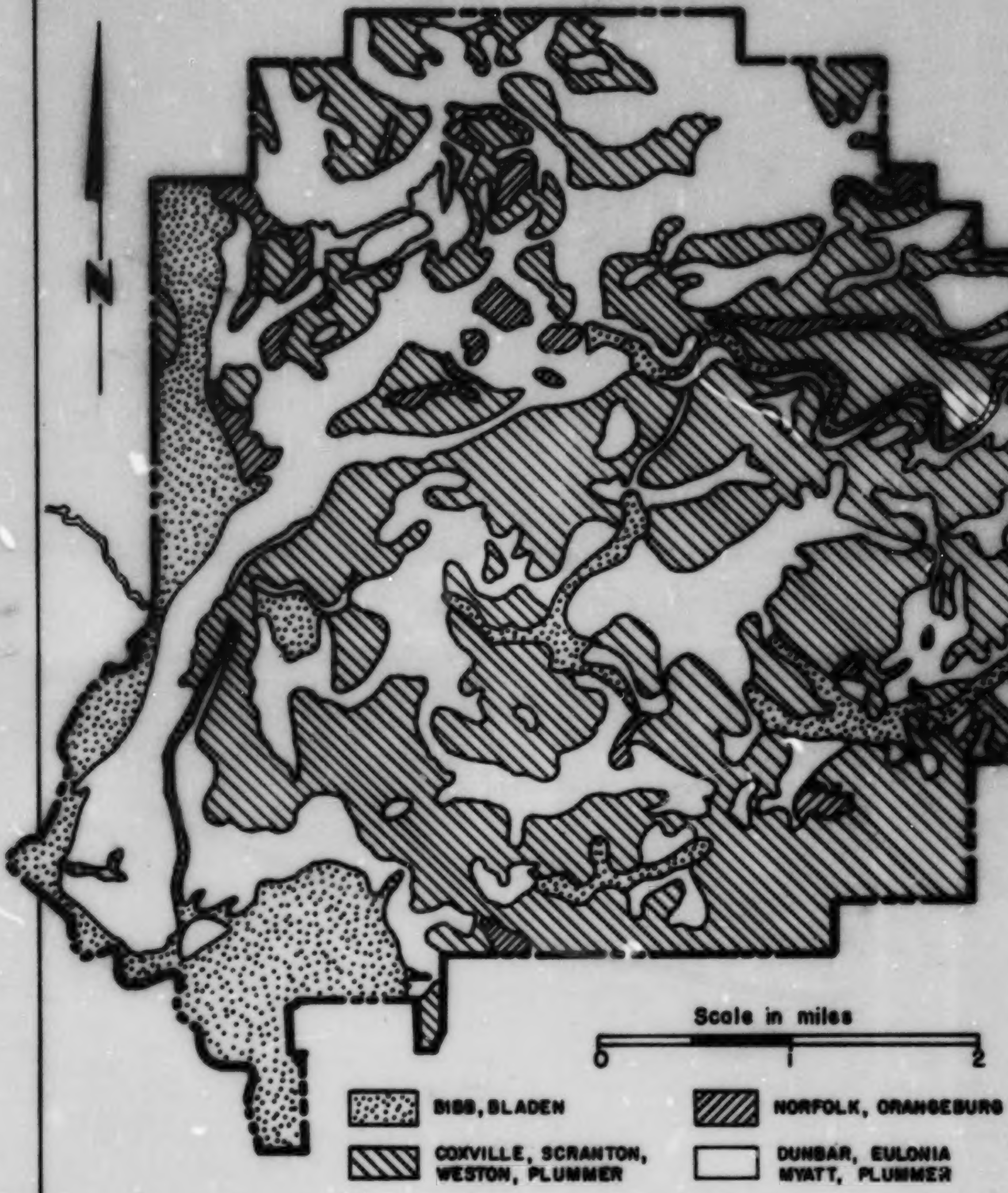
## Soil Classification in the MTF Fee Area

The three major soil groups at the MTF include the Eulonia, the Norfolk, and the Orangeburg. The Eulonia group has been segregated into twelve soil types. These types are:

| | | |
|---|---|---|
| 1. | Bibb | Silty, clayey-loam |
| 2. | Bibb | Very-fine, sandy-loam |
| 3. | Bladen | Loam |
| 4. | Coxville | Very-fine, sandy-loam |
| 5. | Dunbar | Very-fine, sandy-loam |
| 6. | Eulonia | Very-fine, sandy-loam |
| 7. | Myatt | Very-fine, sandy-loam |
| 8. | Plummer | Fine, sandy-loam, flatwood phase |
| 9. | Plummer | Very-fine, sandy-loam |
| 10. | Scranton | Fine, sandy-loam |
| 11. | Scranton | Very-fine, sandy-loam |
| 12. | Weston | Very-fine, sandy-loam |

The Norfolk Group is a very-fine, sandy-loam flatwood phase while the Orangeburg soil group is composed of the Cahaba loamy-fine-sand and Ruston fine-sandy-loam flatwood phase.

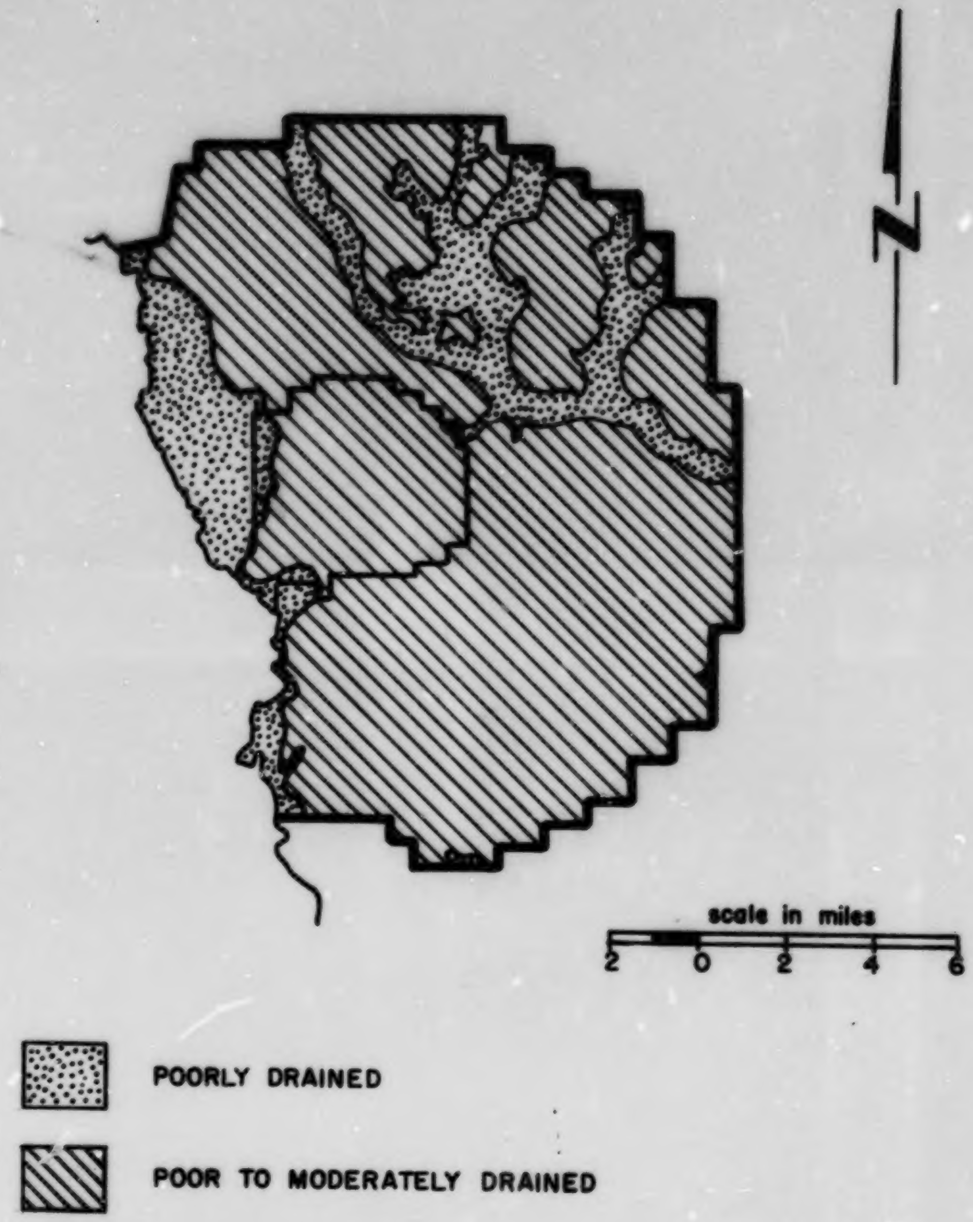
To illustrate common soil characteristics several soil types have been grouped under the same heading to ease the problem of diagrammatically depicting soil-drainage properties (see Figures 25 and 26). Bibb silty-clayey-loams, Bibb very-fine-sandy-loam, and Bladen loam represent soil types which normally


N
Scale in miles
0
1
2
BIBB, BLADEN
NORFOLK, ORANGEBURG
COXVILLE, SCRANTON, WESTON, PLUMMER
DUNBAR, EULONIA MYATT, PLUMMER

THE MTF SOIL CLASSIFICATION - HANCOCK COUNTY, MISS.

U.S. DEPT. OF AGRICULTURE - BUREAU OF CHEMISTRY & SOILS (1930)

Figure 25



SOIL DRAINAGE CHARACTERISTICS OF THE MTF

Figure 26

Modified from US DEPT. OF AGRICULTURE (1970) support timber species such as Cypress, Longleaf Pine and Slash Pine, where located in poorly-drained, highly-organic soil zones (Ref.: U.S. Department of Agriculture, Hancock County Soil Survey, 1930).

The Dunbar very-fine-sandy-loam, the Eulonia very-fine-sandy-loam, the Myatt very-fine-sandy-loam, and the Plummer fine-sandy-loam-flatwood phase have been grouped because they represent soils that are generally better drained than the previously described Bibb-Bladen soils. These soils are gray with localized mottled red and yellow bands. They are usually located in topographically low-lying areas which normally support a wide range of timber and, if managed, these soils could support pasture development.

The Coxville very-fine-sandy-loam, the Plummer very-fine-sandy-loam, the Scranton fine-sandy-loam, the Scranton very-fine-sandy-loam, and the Weston very-fine-sandy-loam are generally poor- to moderately-drained. These soils are usually located on seepage slopes and on topographically level areas. The gray, mottled, sandy-to-clayey soils support various timber species and, when properly managed, these soils may support agricultural activity.

The Norfolk and Orangeburg soil types are grouped together because they are moderately well-drained and represent probably the best drained soils in the MTF area. The soils are sandy and are mottled yellow and red. These types are located on level to moderately sloping topographic positions.

## Soil Classifications in the Buffer Zone of the MTF with Minor Emphasis on the Fee Area

Detailed soil analyses of the MTF Buffer Zone are lacking; however, general soil associations and characteristics have been formulated and described by the U.S. Department of Agriculture, Soil Conservation Service, in cooperation with the Gulf Regional Planning Commission staff and the Mississippi State Highway Department (1972). The soils in the Fee Area (Figure 25) of the MTF are associated with Harleston-Atmore-Lynchburg, Atmore-Lynchburg-Plummer, Weston-Plummer-Byars, and Rosebloom-Collins soil groups.

The Harleston-Atmore-Lynchburg group is located on low ridges and is classified as moderately-well to poorly-drained soils. These drainage characteristics depend on their relation to the local recharge and discharge zones. The Atmore-Lynchburg-Plummer soil group is defined as a poorly-drained, silty, clayey loam. The Weston-Plummer-Byars soil associations are poorly-drained, clayey depressions occupying the northeastern section of the Fee Area of the MTF. The Rosebloom-Collins is a poorly-drained Pearl River floodplain soil group.

These soil groups previously described are also found in the Buffer Zone, but also include the Tidal Marsh, Benndale-Atmore-Harleston, and Ochlockonee-Harleston-Weston soils. These soil associations are illustrated in Figure 26.

The Tidal Marsh soil group is a wet, black, brackish-organic soil which occupies the low-level, wet, grassy flats near the Mississippi Sound. The Benndale-Atmore-Harleston group is moderately well-drained soil occupying the gently-sloping sand ridges. The Ochlockonee-Harleston-Weston group is defined as a well-drained to poorly-drained floodplain soil group. The significance and purpose of emphasizing these soil groups will be discussed in the MTF evaluation section.

The above soil classifications and groups help to illustrate similar soil characteristics and emphasize the drainage problem areas. To clarify the situation, a cross-hatched mapping technique has been used to locate areas of concern. The dotted areas in Figures 25 and 26 represent highly saturated and poorly-drained areas. These locales need careful management and detailed study prior to any development.

The cross-hatched sections represent better-drained, easier to manage soil types. These areas are more removed from surface drainage systems and represent locales where facilities for HMSE testing might be developed. It should be noted, however, that soil types and associated properties constitute only one major consideration needed in the evaluation of possible HMSE test sites. The brief description and synopsis of these soil types performed to date has consisted of only a cursory description of the overall characteristics of the soil properties. In order to better understand the wide range of soil characteristics, the following properties would have to be studied in detail:

1. Moisture content values.
2. Soil water absorption capacities.
3. Soil chemical characteristics--organic, inorganic.
4. Hydraulic conductivities.
5. Soil micro-organisms.
6. Major element macronutrients constituents (N, P, K, Ca, Mg and S).
7. Micronutrients (Fe, Mn, Cu, Zn, B, Mo, Cl, Co).
8. Acidic-basic buffer systems (including the bicarbonate system).
9. Textural analyses.
10. Vegetative-soil relationships.
11. Erodibility-soil stability values.
12. Runoff characteristics for the various soil types.

The intricacies and inter-relationships of these coastal soils and their environments need to be defined and better understood. Understanding these segregated but related soil types will help to accurately define surface water drainage, erosion, sediment transport, and depositional characteristics of the deltaic deposits of the Jourdan and Pearl River systems.

## Sediments of Mississippi Sound and In-Shore Water

The Pearl and Jourdan Rivers supply fresh water to the Mississippi Sound. This interaction of two chemically different surface waters (fresh water/saline water) produces brackish conditions which favor the growth of a wide range of biota. As an example, the Mississippi Sound abounds with shrimp, crabs, oysters, and various fishes supporting a prosperous, local fishing industry in Mississippi.

Pollution in the Mississippi Sound has been attributed,in part, to recent increased industrialization, various pest control measures, and increased use of fertilizers. The shelf area is subject to surface runoff from inland rural and urban areas. In 1952-54, a study financed by the Mississippi Seafood Commission and the Gulf Coast Research Laboratory was conducted to determine physical, chemical, geological and biological characteristics of the bottom material in the Sound. The study suggested that:

1. Detailed analyses of flocculant material must be monitored on a strict schedule.

2. Chemical analyses of water quality must be routinely performed.

3. Oysters, shrimp, and fish should be clinically checked to determine whether any accumulation of toxic substances has been concentrated within their tissues.

4. Sedimentation studies should be initiated to determine the amount and rate of silt and clay build-up in prime oyster bed locations.

The results of the above study also pointed up the need for (1) more research in depositional processes of sediments, and (2) chemical equilibrium research, to determine the rates of formation of various precipitated materials (e.g., iron and aluminum compounds).

Geological investigation of the Pearl River outlet channel sediments and soil characteristics have been described (by Kolb, 1958) in the following summary:

> "Soils summary
>
> "1. Several general conclusions can be drawn concerning location of the channel solely from a soils standpoint. The disposition of the soils in the area is such that should sandy materials be desired from an excavation, slope, or embankment point of view, the best path for the channel would be close to the abandoned course or the major distributary trends. If clayey materials are desired a position as distant from these features, or crossing as few of them, as possible, would be best. If the channel is to take maximum advantage of the highest, most stable land areas in the interest of potential industrial development, firm foundation conditions, etc., it should be located as close as possible to the abandoned course and associated point-bar materials.
>
> "2. Where spoil from the proposed channel is placed on areas consisting of detrital peat, or where the peat overlies high-water-content inter-distributary clays, lateral displacement of the underlying deposits can be expected. This might result in squeezing of these materials into the freshly opened channel unless the spoil is spread over a wide base and at a sufficient distance from the channel. Spoil placed on point-bar, abandoned channel, or abandoned distributary deposits will have little or no effect in compacting these coarser-grained sediments.
>
> "Shoreline changes
>
> "3. The following paragraphs show the interrelation of such natural phenomena as subsidence of the deltaic mass, sediment transport, and shoreline retreat and barrier beach movement, and relate these, where possible, to problems associated with the outlet channel. They are based solely on geologic observation,

unsupported by data on bottom currents, wind velocities, wave heights, etc., and as such, should be considered principally as aids to studies designed to arrive at answers to specific problems based on more tangible data.

"4. The inner islands and Chandeleur Sound. Two of the inner groups of islands, North and Freemason, have decreased in size as much as 50 percent in the past 100 years and have shifted south and east. No significant change seems to have occurred in the New Harbor Islands. Since subsidence, estimated at roughly 2 ft. per 100 years in this inner island area, would have affected all these islands to essentially the same degree, the loss in size must be attributed to wave attack. This view is substantiated by the fact that although the North and Freemason groups have migrated southeastward as much as a mile in 100 years, the New Harbor group, because of its sheltered position, has remained essentially where it was in 1855. Wave wash has been severe and constant enough in the past 100 years to transport the entire North and Freemason groups, particle by particle, southeastward for more than a mile. This implies that any embankment along the proposed channel that reaches to and above the surface of Chandeleur Sound will be subjected to forces capable of moving a land area such as the North Islands 6,000 feet in 100 years, or roughly 60 ft. per year. Careful stabilization or riprapping of such an embankment would be vital.

"5. Just what significance the southeastward movement of these inner islands has in relation to sediment transportation along the bottom of Chandeleur Sound is uncertain. Forces that move near-surface deposits may be ineffective in moving deposits in deep water. An examination of U.S. Coast and Geodetic Survey charts shows an almost imperceptible low on the floor of the sound beginning several miles west of the Freemason Islands and trending northeastward past the northern tip of the Chandeleur Islands.

"6. An important point in this connection is that enclosed and partially enclosed bodies along the Gulf Coast, such as Chandeleur Sound, have saucer-like shapes with remarkably uniform bottoms. The lows in Chandeleur Sound mentioned above may therefore be of significance. Price (reference 3 of the inclosed report), in a study of tidal bays along Texas and Louisiana coasts, has pointed out the relationship of the average width of a particular water body to its depth--the greater the width, the greater the depth. This, he states, is good evidence that the fetch, or distance of translation of wave motion and its causative agency, the surface wind, is directly proportional to wave depth and determines the depth of effective wave scour. The width of the open part of a particular water body determines the fetch, and the depth of the water body is the result of average wind velocity and wave scour. If this is true, the present depth of Chandeleur Sound is the result of wave scour--scour that tends to erode anomalous highs, such as an underwater spoil bank, or fill anomalous lows, such as the proposed channel, so that equilibrium bottom conditions can be maintained.

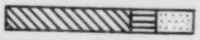
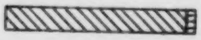
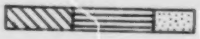
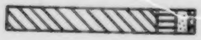
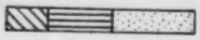
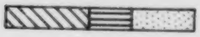
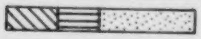
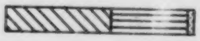
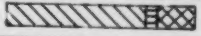
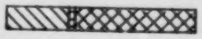
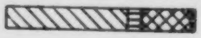
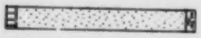
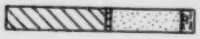
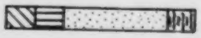
> "7. In substantiating his thesis, Price also points out the converse situation brought about by the artificial segmentation of Corpus Christi Bay by ship channels and their flanking spoil banks. This has produced a degree of silting in each segment--a response to reduction in size which is in the expected direction for maintenance of the proper width-depth equilibrium. The effect of an above-water embankment would, of course, be segmentation of Chandeleur Sound and possibly gradual clay deposition. Whether a continuous underwater spoil bank would have the effect of segmenting the sound is problematic. It would probably depend on the height of this spoil bank and its capability of breaking the force of wave action. Judging from the rate of movement of the North and Freemason groups of islands due to wave attack, it is doubtful if any unrevetted embankment either above or below water would be substantial enough to resist active wave erosion. The tendency would be for wave attack to flatten or disperse any unrevetted, underwater embankment so that original equilibrium bottom conditions could be regained.
>
> "8. Based on this assumption, the most advantageous disposition of the spoil to prevent its moving back into the excavated channel would be in a low bank spread over as wide an area as practicable so that only wave scour of greater than average intensity would be effective in dispersing and shifting the excavated materials. Similarly, the choice of a route through the deepest areas of the sound would have the same effect from the standpoint of wave scour. And finally judging from the direction of movement of the North and Freemason groups of islands during the last 100 years, the spoil should be placed on the south side of the channel.
>
> "9. [Borings] encountered a 35 ft. sequence of silty sand with shell, a lithology that closely resembles that of the bay-sound sediments. If these are bay-sound sediments, the implications are disturbing. The thickness of the sequence implies that bottom currents within Chandeleur Sound are sometimes (perhaps during hurricanes) capable of scouring and redepositing material to this great depth. Another explanation for this anomalous depth of relatively coarse material is that it fills an abandoned course, although abandoned courses are not normally characterized by shell fragments. Borings made in sediments filling other parts of the abandoned St. Bernard Course, and other abandoned courses, have rarely encountered shells. [Borings] were made near the seaward end of what may be an abandoned St. Bernard Course or distributary where sediments distinctly more marine and shelly in nature may be expected." (Ref.: Kolb, C.R., U.S. Army Engineers Waterways Experiment Station, Corps of Engineers, 1958).

The sediments were deposited in pro-delta clays; pro-delta, intra-delta, nearshore and Gulf levees; point-bars, inter-distributary deposits; swamps; marshes; lacustrine bay-sound barrier beaches; abandoned courses; and sand beaches. The characteristics of these deposits are summarized in Figure 27.

# Figure 27

## PHYSICAL CHARACTERISTICS OF DEPOSITIONAL TYPES

## MISSISSIPPI RIVER-GULF OUTLET CHANNEL

| Depositional Types Coastal Environment | Lithology | ST[1] | PI[2] | SS[3] |  | Remarks |
|---|---|---|---|---|---|---|
|  |  |  |  | CS[4] | IF[5] |  |
| Pleistocene<br>Varied |  | CH & CL | 10-30 | 900-3000 | 0 | Forms terraces in MTF area. |
| Prodelta Clays<br>Fluvial-Marine |  | CH | 30-55 | 200-600 | 0 | Underlies entire deltaic sequence as homogeneous unit. Slopes & thickens toward the southeast. |
| Intradelta Complex<br>Fluvial-Marine |  | CH<br>ML | 15-60<br>NP-10 | Insufficient data-moderate |  | Relatively (coarse portion of subaqueous delta) interfingered deposits. Disposed in broad wedges about abandored courses and major distributaries. |
| Interdistributary Trough<br>Fluvial-Marine |  | CH | 30-75 | 150-300 | 0 | Disposed in clay wedges between major distributaries. Clay sequences interrupted by silty or sandy materials associated distributaries. |
| Abandoned Course<br>Fluvial |  | CL & SP | Insufficient data | Insufficient data-fairly high |  | Coarse sediment in abandoned Pearl River course. Grain size increases with depth and in upstream direction. |
| Abandoned Distributary<br>Fluvial |  | CL & SP | Insufficient data | Insufficient data-fairly high |  | Fairly coarse sediment 9-1500' wide and 30-60 ft. deep. Grain sizes increase with depth. |
| Point Bar<br>Fluvial |  | ML & SM<br>SP | 10-70<br>NP | Insufficient data-fairly low | 25-35 | Flanking major courses. Thickness 80 ft. or more. Materials become coarser with depth. |
| Natural Levees<br>Fluvial |  | CH & CL<br>ML | 10-30<br>NP-5 | 800-1200 | 15-35 | Disposed in irregular belts along abandoned courses & distributaries. Thickness averages 15 ft. or less. |
| Swamp<br>Paludal |  | OH | 30-60 | Insufficient data | -- | Relatively small areas inland and on offshore islands. |
| Marsh<br>Paludal |  | PT | -- | Very Low | -- | Average thickness 10 ft. very high water content. Subject to rapid compaction under load. |
| Lacustrine<br>Paludal |  | OH & CH | 25-60 | 100-200 | 0 | Widely scattered within marsh--may be considered as part of marsh sequence. |
| Sand Beach<br>Marine |  | SP | NP | 0 | 30-35 | Surficial beaches of minor areal extent. Buried beaches also insignificant portion of subsurface (Cheniers). |
| Bay/Sound<br>Marine |  | CH<br>SM & SP | 25-45<br>NP | 200-600 | 0<br>15-30 | Average 10-15 ft. deep throughout Chandeleur Sound. Interfingered, characteristically silts and sand deposits. |
| Nearshore Gulf<br>Marine |  | SP | NP | 0 | 25-35 | A basal sandy unit beneath the prodelta clays and seaward of the Chandeleur arc of islands. |

[1] Soil Textures--major soil textural characteristics symbols, based on unified soil classification system.

[2] Plastic Index--Atterberg limits do not reflect water contents of highly organic materials.

[3] Shear Strength--cohesive strengths of clays based on unconfined compression tests.

[4] Cohesive Strength lb./sq. ft.

[5] Angle of Internal Friction in degrees.

LEGEND: ▧ Clay (0.002 mm) ▤ Silt (0.06-0.002 mm) ░ Sand (2.0-0.06 mm) ▩ Organic material.
▥ Shell

Modified after Kolb and Van Lopik, 1965

## HYDROLOGIC ASPECTS OF SOUTHWESTERN MISSISSIPPI AND THE MTF AREA

> "Ownership of the natural water systems resides in the citizens collectively and their control is relegated to the state. This concept is upheld by both tradition and common law. A set of inalienable collective rights then follows a priori. These. . .are:
>
> 1. A right to water for drinking, free from contamination by other uses.
> 2. A right to harvest the aquaculture of these waters for individual consumption without risk to health.
> 3. A right to enjoy the recreational and esthetic benefits of the natural water system." (Ref.: Millar, Jr., 1971).

The MTF site may enhance the chance of protecting part of our natural resources by developing the proposed HMSE Facility. An understanding of the detailed biological, chemical, and physical parameters and inter-relationships (environmental baseline) is necessary in order to comprehend fully the total impact of any of the wide range of potential pollutants (e.g., hazardous materials) in relation to a balanced ecosystem. A well-quantified environmental baseline in an area such as the MTF would be necessary in order to: (1) ensure the safety factor during open or semi-closed testing; (2) provide meaningful pre-, during, and post-descriptions of the area affected--this is needed especially for quantifying the effects of a given particular test; and (3) ensure that the open or semi-closed tests in future demonstrations would not be affected by previous residues or elevated background levels.

### Groundwater

This study deals primarily with the definition of geological and hydrological conditions in the immediate area of the MTF. Groundwater in sediments younger than Early Miocene (10-25 million years) will be discussed in detail because older sediments have not been adequately defined to evaluate their hydrologic characteristics.

The Pascagoula (Miocene) formation is one of the thickest aquifer sequences with the best hydraulic properties in Southern Mississippi. The wells drilled in this formation have hydrostatic pressures capable of raising water 40-70 ft above mean sea level (msl). The water quality varies locally depending on the amount of sea-water intrusion via lateral and/or vertical seepage. The Mid-Miocene (Hattiesburg) and Lower Miocene (Catahoula) beds are relatively thick (up to 6,200 ft ); however, these units have not been extensively developed for water supplies because water sources at shallower depths are easier to develop, of better quality and present in greater quantity.

The Pliocene deposits (e.g., the Graham Ferry formation, a thick [125-9,000 ft.] deltaic deposit with several excellent aquifers) are used for industrial and domestic use in Hancock County. These deposits are coarse-grained, porous, confined aquifers which have hydrostatic pressures capable of raising a column of water 30-80 ft above mean sea level. The transmissivity of these units ranges from 20,000 to 200,000 gallons per day per foot drawdown (Ref.: Newcome, 1967). (Transmissivity is the volume of water that will move during a unit of time through a vertical strip of the aquifer of unit with a unit head.)

Pleistocene sand and gravel aquifers in Hancock County may provide domestic waters, when they are conservatively tapped, so that saltwater encroachment may be prevented (Ref.: Brown *et al.*, 1944). Many drilled wells in coastal Pleistocene domestic sediments, in the vicinities of Biloxi and Bay St. Louis, have been abandoned due to poor water management. These wells either have been tapped and left flowing or have been pumped so heavily that saline water has reduced water quality. These Recent or Holocene sediments in some areas have been contaminated also with domestic sewage (Ref.: Shattles & Callahan, 1970).

The deeper Miocene-Pascagoula and the Pliocene-Graham Ferry formations show little or no evidence of saline water encroachment to date. The Miocene-Pascagoula formation, however, shows concentrated chlorides (1,000-35,000 ppm [Ref.: Grim, 1928]) in deeper formations, due to saline water being contemporaneously trapped with deltaic sediments.

In controlled, scientific hydrologic studies, the movement of groundwaters and surface waters must be understood prior to any large scale, open-ecosystem study. The MTF site appears to be hydraulically controlled by:

1. The *deep regional flow system*, governed by thick, permeable, porous sandy sediments underlying recent heterogeneous deposits.
2. The *intermediate thick, southerly-dipping* recent sediments which originate in Central Mississippi and extend into the Mississippi Sound.
3. *Recent deltaic deposits* which form the local topography in the vicinity of the MTF.

In summary, the best freshwater aquifers in Mississippi in order of importance are listed in the right-hand column. The equivalent geologic time is listed in the left-hand column (modified after Priddy, 1955):

| Order of Age | Order of Importance |
|---|---|
| 14. Pleistocene (youngest) | 1. Pliocene (Graham Ferry) (most used) |
| 13. Pliocene | 2. Miocene (Pascagoula) |
| 12. Miocene | 3. Pleistocene (Citronelle) |
| 11. Vicksburg-Oligocene | 4. Wilcox-Eocene |
| 10. Forest Hill-Oligocene-Eocene | 5. Sparta-Eocene |
| 9. Cockfield-Eocene | 6. Cockfield-Eocene |
| 8. Sparta-Eocene | 7. Tuscaloosa-Cretaceous |
| 7. Winona-Eocene | 8. Winona-Eocene |
| 6. Wilcox-Eocene | 9. Eutaw-Cretaceous |
| 5. Eutaw-Cretaceous | 10. Pennsylvanian |
| 4. Tuscaloosa-Cretaceous | 11. Mississippian |
| 3. Pennsylvanian | 12. Vicksburg-Oligocene |
| 2. Mississippian | 13. Forest Hill-Oligocene-Eocene contact |
| 1. Devonian (oldest) | 14. Devonian (least used) |

## MTF Groundwater Evaluation

In 1967, the deep groundwater system was defined when the USGS was contacted by NASA to define groundwater resources in terms of providing an adequate, long-term supply of groundwater for cooling test stands during experimental static firings of the Saturn V rocket. Several wells were drilled to determine selected aquifer characteristics as well as to evaluate the quantity and quality of the groundwater resources beneath the MTF rocket test sites. Logs 1-52, located in Figure 28 (see also Table 4 ), depict the characteristics of subsurface material while Table 6 defines geochemical qualities of various permeable zones. The pertinent characteristics of the 6 drilled wells are described in the following summary:

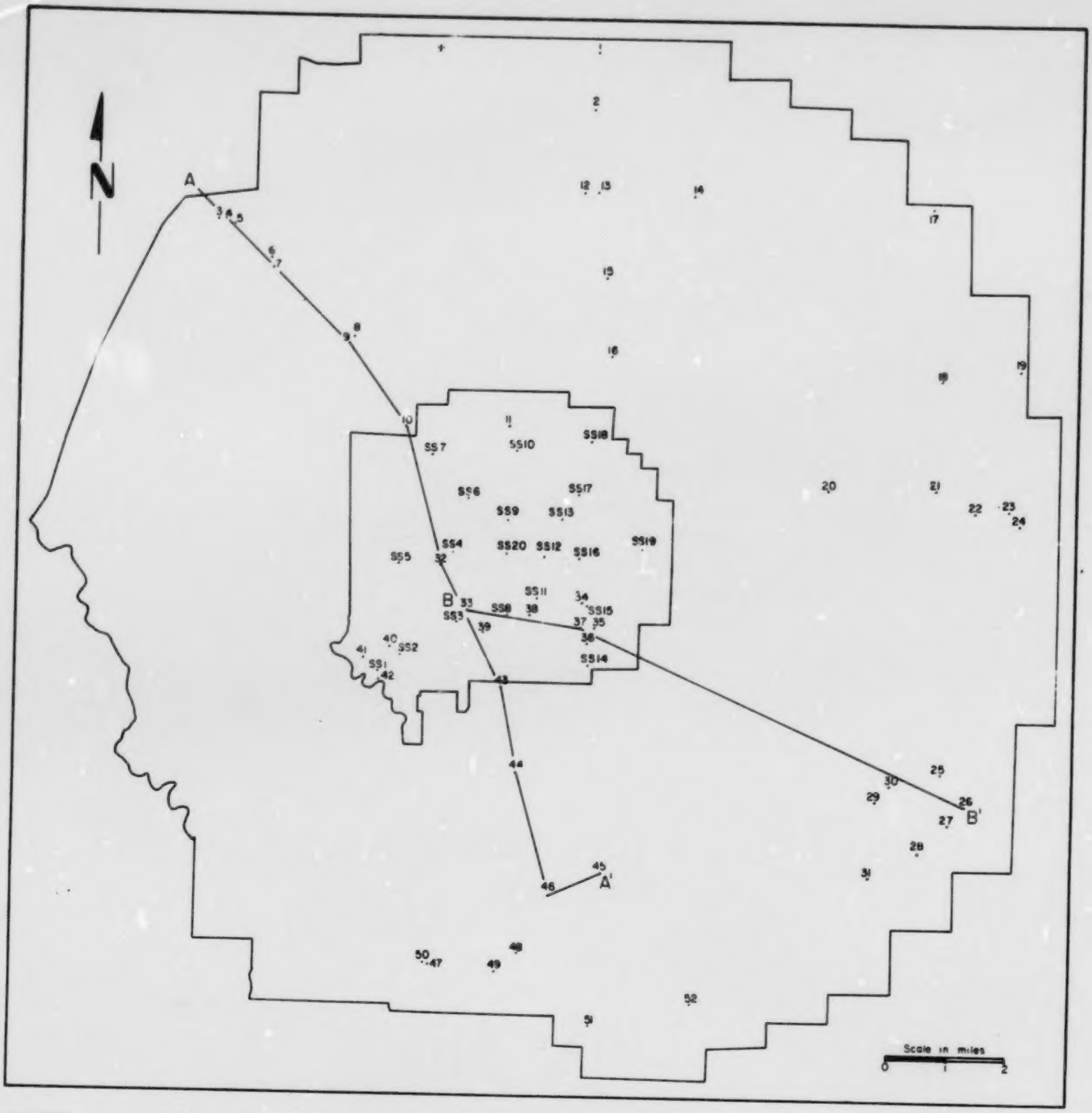
A. These data (see Table 6 ) illustrate the water-bearing interval of the tapped aquifer as well as describing in detail $SiO_2$, Fe, Mg, Na, K, $PO_3$, $CO_3$, $SO_4$, Cl, F, $NO_3$, dissolved solids, hardness as $CaCO_3$, pH, color, and hydraulic properties. Also, detailed well analyses for selected sites located in the Fee Area and Buffer Zone are illustrated in Figure 28 with the pertinent well characteristics described in Tables 5 , 6 , and 7 , (all data from Roy Newcome, 1967).

B. Various pump tests were conducted to determine the characteristics of these aquifers which are illustrated in Table 6 . Table 7 depicts aquifer properties which illustrate that the artesian aquifers have high hydrostatic pressures (ranging from 15 to 104 ft. above msl). These pressures, however, have been reduced in the past due to poor management practices and to increased pumpage from the major aquifers. It has been suggested that pressures have declined because artesian aquifers have been tapped and not only utilized for domestic use, but allowed to intentionally (or unintentionally) flow uncontrolled and unused. Figures 29 and 30 illustrate the coastal aquifers' pressures and levels (saline/fresh water interface) in recent years (these have been on the decline). It should be realized that the shutting off of these wells would probably result in eventual well failure because of clogging with sand or mud.

The recent development of several wells in varying stratigraphic zones has tended to mitigate hydrologic problems that might result from the overdevelopment of a single aquifer. The feasibility of developing certain aquifers in Southwest Mississippi for future groundwater industrial supplies is thus enhanced because groundwater supplies at any one point in a specific aquifer have not been depleted or contaminated through excessive groundwater mining.

Recent preliminary studies have indicated that the MTF aquifers are not hydraulically connected vertically (Ref.: Newcome, 1967). Figure 31 illustrates stratigraphic-aquifer relationships and depicts zones where groundwater resources have been developed. The lack of vertical connections may be the case for the drilled test wells, but further testing is needed to determine whether all aquifers in the area are vertically segregated from one another.

The Army Corps of Engineers, in Mobile, Alabama (1965), conducted a drilling survey in various locations throughout the Fee and Buffer Zones of the MTF. The soil sampling cores helped to describe the lithologic characteristics of, and furnish additional information about, the static water levels in both the Buffer and Fee Areas.



**LEGEND**

1-52 DEEP PENETRATING WELLS

SS1-SS20 SOIL SAMPLING SITES

The MTF WELL LOG POINTS

(See Table 4 for further explanation)

Figure 28

## Table 4. MTF WELL LOG DESCRIPTION[a]
(Well Points Located on Figure 28)

| Well # [b] | A | B | C | D | E | F | G | H | I | J[c] | K[d] | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6 | 16 | -- | 80 | 600 | 2.5 | + 2.0 | 6-05-64 | -- | 76 | --- | -- |
| 2 | 6 | 16 | -- | 70 | 1000 | 2.0 | +27.0 | 7-24-64 | -- | 81 | --- | -- |
| 3 | 7 | 17 | -- | 30 | 750[e] | 2.0 | +46.1 | 7-08-65 | -- | 80 | --- | -- |
| 4 | 7 | 17 | 1950 | 36 | 728 | 2.0 | +17.3 | 7-18-65 | -- | -- | --- | -- |
| 5 | 7 | 17 | 1959 | 37 | 980 | 2.0 | +41.3 | 7-08-65 | -- | 80 | 294 | 2.5 |
| 6 | 7 | 17 | -- | 30 | 400[e] | 2.0 | +21.1 | 7-08-65 | -- | 73 | 477 | 3.3 |
| 7 | 7 | 17 | 1924 | 45 | 506 | 3.0 | - 5.8 | 7-22-64 | -- | -- | --- | 5.0 |
| 8 | 7 | 17 | -- | 35 | 840 | 2.0 | +51.0 | 7-08-65 | -- | 82 | 304 | 2.6 |
| 9 | 7 | 17 | 1928 | 36 | 767 | 4.0 | +20.2 | 7-08-65 | -- | 78 | 441 | 5.8 |
| 10 | 7 | 16 | -- | 30 | 980 | 2.0 | +58.0 | 7-08-65 | -- | 83 | 403 | 16.0 |
| 11 | 7 | 16 | -- | 30 | 930 | 2.0 | +56.5 | 7-08-65 | -- | 82 | 394 | 24.0 |
| 12 | 7 | 16 | 1964 | 56 | 1250 | 2.0 | +44.5 | 7-19-64 | -- | 85 | 363 | 16.0 |
| 13 | 7 | 16 | -- | 57 | 800[e] | 2.0 | --- | --- | -- | 81 | 497 | 4.5 |
| 14 | 7 | 16 | -- | 60 | 975 | 2.0 | +47.0 | 12-09-64 | -- | 80 | 413 | 6.9 |
| 15 | 7 | 16 | -- | 40 | -- | 2.0 | - 7.08 | 7-09-65 | -- | -- | --- | -- |
| 16 | 7 | 16 | -- | 30 | 1000 | 4.0 | + 2.0 | 6-12-64 | -- | -- | --- | -- |
| 17 | 7 | 15 | 1908 | 40 | 500[e] | 6.0 | --- | --- | -- | 74 | 359 | 4.0 |
| 18 | 7 | 15 | -- | 52 | 1030? | 2.0 | +60.0 | 7-09-65 | -- | 90 | --- | -- |
| 19 | 7 | 15 | -- | 38 | 700 | 2.0 | + 8.0 | 7-19-65 | -- | 76 | --- | -- |
| 20 | 7 | 15 | 1955 | 26 | 523 | 12.0 | --- | --- | -- | 75 | 401 | 4.6 |
| 21 | 7 | 15 | 1938 | 17 | 582 | 3.0 | +34.0 | 6-04-65 | -- | -- | --- | -- |
| 22 | 7 | 15 | 1949 | 20 | 670 | 4.0 | +20.0 | 6-04-64 | -- | 80 | --- | -- |
| 23 | 7 | 15 | 1950 | 15 | 644 | 6.0 | +36.5 | 4-20-65 | 300 | 79 | --- | -- |
| 24 | 8 | 15 | -- | 20 | 1000? | 4.0 | +27.0 | 7-22-64 | -- | 78 | 409 | 24.0 |
| 25 | 8 | 15 | -- | 9 | 900 | 2.0 | +28.5 | 7-21-64 | -- | 78 | --- | -- |
| 26 | 8 | 15 | 1928 | 6 | 739 | 3.0 | +35.1 | 7-21-64 | -- | 80 | 470 | 27.0 |
| 27 | 8 | 15 | -- | 5 | 1300 | 4.0 | +30.6 | 7-08-65 | -- | 78 | 560 | 41.0 |
| 28 | 8 | 15 | -- | 16 | 500[e] | 2.0 | +14.0 | 4-19-65 | -- | 76 | 467 | 27.0 |
| 29 | 8 | 15 | 1917 | 11 | 300 | 2.0 | + 3.7 | 6-18-64 | -- | 72 | --- | -- |
| 30 | 8 | 15 | -- | 16 | 640 | 2.0 | --- | --- | -- | 78 | --- | -- |
| 31 | 8 | 15 | 1954 | 18 | 860 | 2.0 | +14.2 | 7-08-65 | -- | 74 | 489 | 32.0 |
| 32-37 | Data is found in Table 6 . | | | | | | | | | | | |

Table 4 (continued). MTF WELL LOG DESCRIPTION[a]
(Well Points Located on Figure 28)

| Well #[b] | A | B | C | D | E | F | G | H | I | J[c] | K[d] | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38 | 8 | 16 | 1964 | 25 | 140 | 10.0 | --- | --- | -- | 69 | --- | -- |
| 39 | 8 | 16 | 1963 | 26 | 361 | 2.0 | - 2.0 | --- | -- | -- | --- | -- |
| 40 | 8 | 16 | -- | 22 | 800[e] | 2.0 | +34.5 | 1-12-65 | -- | 80 | --- | -- |
| 41 | 8 | 16 | 1964 | 25 | 954 | 2.0 | +55.0 | 7-08-65 | -- | 76 | 335 | 2.0 |
| 42 | 8 | 16 | -- | 22 | -- | 3.0 | - 0.7 | 7-08-65 | -- | -- | --- | -- |
| 43 | 8 | 16 | -- | 20 | 900 | 2.0 | +56.5 | 7-08-65 | -- | 75 | 411 | 23.0 |
| 44 | 8 | 16 | -- | 16 | 420[e] | 4.0 | + 4.8 | 7-08-65 | -- | 74 | 601 | 24.0 |
| 45 | 8 | 16 | -- | 26 | 1323 | -- | +56.0 | 7-08-65 | -- | 87 | 432 | 20.0 |
| 46 | 8 | 16 | -- | 21 | 766 | 2.0 | + 4.7 | 7-08-65 | -- | 79 | 682 | 37.0 |
| 47 | 9 | 16 | -- | 20 | 650[e] | 2.0 | + 3.5 | 7-21-64 | 4 | 78 | 659 | 26.0 |
| 48 | 9 | 16 | -- | 15 | -- | 2.0 | +10.8 | 7-08-65 | -- | -- | 606 | 23.0 |
| 49 | 9 | 16 | -- | 12 | 500[e] | 2.0 | + 3.0 | 7-21-64 | 3 | 75 | 548 | 28.0 |
| 50 | 9 | 16 | 1955 | 20 | 720 | 2.0 | + 3.6 | 7-21-64 | -- | -- | --- | -- |
| 51 | 9 | 16 | 1952 | 10 | 809 | 2.0 | +19.9 | 7-23-64 | -- | 78 | 768 | 60.0 |
| 52 | 9 | 16 | 1938 | 20 | 675 | 3.0 | + 3.7 | 7-08-65 | -- | 78 | --- | -- |

[a] From Newcome, 1967.

[b] See next page for list of well owners (or tenants) and key to column headings.

[c] Measured at land surface--may be lower than temperature in aquifer.

[d] Multiply by 0.65 to obtain approximate dissolved solids concentration.

[e] Depth calculated using thermal gradient. Well is at least this deep, and may be deeper.

## Table 4 (continued). MTF WELL LOG DESCRIPTION
## (List of Well Owners and Key to Column Headings)

1. John Wheat
2. Flattop School
3. Prentiss Kennedy
4. Hubert Stevenson
5. Curtis Wheat
6. Dave McQueen
7. Allen Craft
8. Mrs. E.M. Frierson
9. Weston Lumber Company
10. Mr. Robertson
11. NASA
12. Bill Adams
13. W.E. Thompson
14. C.P. Slay
15. Verne Kirby
16. Gertrude Todt
17. Abraham Solomon
18. Rufus Moran
19. Louis Craddock
20. L.L. Fletcher
21. Loyd B. Briffith
22. L.C. Taylor
23. NASA (formerly Wm. Bosworth)
24. Mr. Cole
25. NASA
26. J.B. Fasterlinger, Jr.
27. Aqua Plantation
28. NASA
29. T. Zingarling
30. T. Zingarling
31. L.E. Nicholson

38. NASA
39. NASA
40. NASA
41. NASA
42. NASA
43. State of Mississippi
44. NASA
45. L.W. Brooks
46. D.F. Stephens
47. J.A. Sacredode
48. Jerome W. Whipple
49. Manuel Borges
50. C.E. Wright
51. Charles W. McCarty
52. State of Mississippi

Key:

| | |
|---|---|
| A | Location as Township South |
| B | Location as Range West |
| C | Year Drilled |
| D | Elevation (in ft.) |
| E | Depth (in ft.) |
| F | Diameter of Well (in in.) |
| G | Water Level Above or Below Land Surface |
| H | Date of Measurement |
| I | Flow Rate (in gpm) |
| J | Temperature (in °F) |
| K | Specific Conductance (micromhos @ 25°C) |
| L | Chloride (in ppm) |

Table 5. MTF LOGS OF BORINGS[a]
(Located on Figure 28)

| | Soil sample depth, ft. | Description |
|---|---|---|
| #1 | 0-9 | Silt |
| | 9-12 | Clayey sand |
| | 12-13.5 | Silt |
| | 13.5-15 | Fat clay |
| | 15-16 | Lean clay |
| | 16-18 | Silty sand |
| | 18 | Water table |
| | 18-22 | Sand |
| | 22-26.5 | Silty sand |
| | 26.5-37 | Sand |
| | 37-38.5 | Silty sand |
| | 38.5-40 | Sand |
| | 40-41.5 | No sample taken |
| | 41.5-50.5 | Sandy, fat clay, with organic matter in lower foot |
| | 50.5-58 | Grey, silty sand |
| | 58-61 | Silty sand |
| | 61-64 | Silty sand |
| | 64-70 | Sand |
| | 70-74.3 | Sand with gravel |
| #2 | 0-4.5 | Silty clay with sand |
| | 4.5-6 | Fat clay |
| | 6-7.5 | Sandy clay with layers of clayey sand |
| | 7.5-13.5 | Poorly graded sand, with trace of clay |
| | 11 | Water table |
| | 13.5-16.5 | Fat clay, with trace of sand in upper portion |
| | 16.5-25.5 | Poorly graded sand |
| | 25.5-27 | Organic matter with trace of sand |
| | 27-42 | Poorly graded sand with trace of clay at bottom |
| | 42-43.5 | No sample taken |
| | 43.5-48 | Fine grained, sandy clay |
| | 48-55.5 | Fat clay, with sand lenses |
| | 55.5-57 | Clayey sand |
| | 57-66 | Poorly graded sand |
| | 66-67.5 | No sample taken |
| | 67.5-73.5 | Poorly graded sand with trace of clay |
| #3 | 0-1.5 | Clayey fine silt |
| | 1.5-7.5 | Sandy clay |
| | 7.5-9 | Silty sand |
| | 9 | Water table |
| | 9-10.5 | Silty sand with slight trace of clay and mica |
| | 10.5-12 | Clayey silt with fine sand layers |
| | 12-15 | Lean clay |
| | 15-18.5 | Organic clay |
| | 18.5-42.5 | Silty sand, some with organics and micaceous |

Table 5 (continued). MTF LOGS OF BORINGS[a]

| | Soil sample depth, ft. | Description |
|---|---|---|
| #3 | 42.5-44 | Lean clay with sand lenses |
| | 44-48.5 | Fat clay with sand lenses |
| | 48.5-50 | Undecayed wood core, presumably log |
| | 50-51.5 | Organic fat clay |
| | 51.5-60.5 | Fat clay with silt lenses, some mica |
| | 60.5-62 | Silty clay, sample saturated |
| | 62-63.5 | Clayey, fine sand with silt lenses, saturated |
| | 63.5-73 | Silty sand, saturated near top |
| | 73-74.4 | Sand with gravel |
| | 74.4-75.9 | Silty sand |
| | 75.9-83.5 | Sand, gravel towards bottom |
| | 83.5-91 | Silty sand, micaceous |
| | 91-113.5 | Poorly graded sand with pea gravel |
| | 113.5-116.5 | Gravel/sand mixture |
| | 116.5-118 | No sample taken |
| | 118-119.5 | Gravelly sand |
| | 119.5-126 | Gravel/sand mixture |
| | 126-129 | Gravelly sand |
| | 129-132 | Gravel/sand mixture |
| | 132-133.5 | Gravelly sand |
| | 133.5-139.5 | Gravel/sand mixture |
| | 139.5-141 | Silty clay with small layers of fat clay, with lenses of fine sand |
| | 141-142.5 | No sample taken |
| | 142.5-150 | Clayey sand with lenses of silt, saturated at top |
| | 150-165 | Silty sand with clay |
| | 165-166.5 | Fat clay |
| | 166.5-180 | Silty clay with lean clay, micaceous at bottom |
| | 180-185 | Fat clay with lenses of silt |
| | 185-195 | Lean clay with layers of fat clay, slightly fossiliferous |
| | 195-205 | Fat clay with layers of silty clay |
| | 205-215 | Silty clay with layers of lean clay |
| | 215-220 | Very fine grained sand and silt mixture, micaceous |
| | 220-225 | Clayey, fine sand with silt layers, micaceous |
| | 225-235 | Silty to sandy clay, micaceous |
| | 235-240 | Clayey silt with fine sand layers, micaceous |
| | 240-250 | Silty clay with lean clay lenses, trace of silt at lower portion, micaceous |
| | 250-255 | Clayey silt with fine sand lenses, micaceous, free water in samples |
| | 255-260 | Sand/silt mixture, micaceous, free water |
| | 260-265 | No sample taken |
| | 265-270 | Clayey silt with fine sand lenses and silt stone fragments, micaceous |
| | 270-285 | Silty clay, with some sand and silt |
| | 285-290 | Clayey silt with fine sand lenses, micaceous |
| | 290-295 | No sample taken |
| | 295-298 | Silty sand, micaceous |

Table 5 (continued). MTF LOGS OF BORINGS[a]

| | Soil sample depth, ft. | Description |
|---|---|---|
| #4 | 0-4.5 | Clayey sand |
| | 4.5-6 | Silty clayey sand |
| | 6 | Water table |
| | 6-7.5 | Sand |
| | 7.5-13.5 | Silty sand |
| | 13.5-31.5 | Fat clay, with organic material, sandy at bottom |
| | 31.5-33 | Silty, clayey sand |
| | 33-34.5 | Sand with organic material |
| | 34.5-36 | Silty sand |
| | 36-39 | Sand |
| | 39-43.5 | Silty sand |
| | 43.5-57 | Fat clay |
| | 57-58.5 | Silty, clayey sand |
| | 58.5-60 | Silty sand |
| | 60-66 | Sand |
| | 66-69 | Silty sand |
| | 69-72 | Sand, gravel at bottom |
| | 72-73.5 | Silty sand |
| | 73.5-75 | Sand with gravel |
| #5 | 0-4.5 | Clayey silt with lenses of fine grain sand |
| | 4.5-6 | Silty clay with fine sand lenses |
| | 6-7.5 | Fat clay with sand lenses |
| | 7.5-10 | Silty sand with clay lenses |
| | 10 | Water table |
| | 10-13.5 | Silty sand, slightly micaceous |
| | 13.5-15 | Fine grained clayey sand, with silt layers |
| | 15-22.5 | Fat clay with iron oxide lenses and some sand lenses |
| | 22.5-28.5 | Sandy clay with clayey sand in bottom |
| | 28.5-42 | Silty sand, micaceous |
| | 42-48 | Fat clay with sand layers |
| | 48-49.5 | Organic fat clay with clayey sand in lower half |
| | 49.5-51 | Clayey sand |
| | 51-54 | Silty sand with trace clay, micaceous |
| | 54-55.5 | Poorly graded sand with iron oxide |
| | 55.5-57 | No sample taken |
| | 57-58.5 | Poorly graded sand |
| | 58.5-60 | No sample taken |
| | 60-67.5 | Poorly graded sand with iron oxide |
| | 67.5-69 | No sample taken |
| | 69-72 | Poorly graded sand, some gravel at bottom |
| | 72-73.5 | No sample taken |
| | 73.5-75 | Poorly graded sand |

Table 5 (continued). MTF LOGS OF BORINGS[a]

| | Soil sample depth, ft. | Description |
|---|---|---|
| #6 | 0-3 | Clayey, fine sand with silt lenses |
| | 3-7.5 | Sandy clay with silt |
| | 7.5-9 | Clayey, fine sand with silt lenses |
| | 9-24 | Slightly micaceous, silty sand |
| | 12 | Water table |
| | 24-30 | Silty, lean clay with sand lenses |
| | 30-31.5 | Slightly micaceous, clayey sand with silt lenses |
| | 31.5-42 | Silty sand with trace mica, clay lenses at top |
| | 42-45 | Fine sand |
| | 45-58.5 | Silty sand |
| | 58.5-60 | Sand |
| | 60-72 | Silty sand with mica traces |
| | 72-73.5 | No sample taken |
| | 73.5-75 | Micaceous, silty sand |
| | 75-76.5 | Clayey sand with pea gravel |
| | 76.5-78 | Micaceous, silty sand with clay traces |
| | 78-79.5 | Sand |
| | 79.5-84 | Fat clay |
| | 84-85.5 | Clayey sand with silt lenses and mica |
| | 85.5-87 | Sandy clay with silt lenses, clayey sand layer and mica |
| | 87-90 | Micaceous, clayey sand with silt lenses |
| | 90-91.5 | Silty gravel |
| | 91.5-108.5 | Gravel |
| | 108.5-110 | No sample taken |
| | 110-111.5 | Organic, fat clay |
| | 111.5-112.5 | Fat clay with organic layers |
| | 112.5-123 | Gravel, clay lenses at top |
| | 123-124.5 | No sample taken |
| | 124.5-127.5 | Clayey, fine sand with silt lenses and organic matter |
| | 127.5-131 | Silty sand with organic matter and mica |
| | 131-189 | Fat clay with organic matter and sand lenses halfway down |
| | 189-212 | Lean or silty clay with sand lenses, micaceous |
| | 212-224 | Micaceous, clayey fine sand with silt lenses |
| | 224-227 | Micaceous, silty clay with sand lenses and rock fragments |
| | 227-242 | Silty clay with sand lenses, micaceous and rock fragments |
| | 242-248 | Slightly micaceous, silty sand |
| | 248-251 | Micaceous, clayey, fine sand with silt lenses |
| | 251-257 | Micaceous, silty sand |
| | 257-263 | Sand |
| | 263-281 | Micaceous, silty sand, with few rock fragments at bottom |
| | 281-300 | Sand |
| #7 | 0-10.5 | Silty sand |
| | 10.5 | Water table |
| | 10.5-12 | Silty sand |
| | 12-13.5 | No sample taken |
| | 13.5-16.5 | Silty sand |

Table 5 (continued). MTF LOGS OF BORINGS[a]

| | Soil sample depth, ft. | Description |
|---|---|---|
| #7 | 16.5-18 | No sample taken |
| | 18-28.5 | Fat clay with organic matter, sandy at bottom |
| | 28.5-31.5 | Clayey sand |
| | 31.5-33 | Fat clay |
| | 33-34.5 | Clayey sand |
| | 34.5-37.5 | Lean clay |
| | 37.5-39 | Clayey sand |
| | 39-42 | Lean clay |
| | 42-45 | Sandy, fat clay |
| | 45-46.5 | Lean clay |
| | 46.5-48 | Sandy, fat clay |
| | 48-50 | Clayey sand |
| | 50-54 | Sandy, fat clay |
| | 54-58.5 | Silty sand |
| | 58.5-61.5 | Fat clay |
| | 61.5-75 | Sand |
| #8 | 0-1.5 | Micaceous clayey silt |
| | 0 | Water table |
| | 1.5-7.5 | Sandy clay |
| | 7.5-12 | Fine to medium grain sand |
| | 12-13.5 | Very fine, silty sand |
| | 13.5-16.5 | Clayey silt with mica |
| | 16.5-27 | Fat clay, shell fragments at bottom |
| | 27-30 | Organic clay with trace sand |
| | 30-31.5 | Silty sand with clay layers and organic matter |
| | 31.5-49.5 | Fine to medium grain sand |
| | 49.5-55.5 | Coarse grain sand |
| | 55.5-60.5 | Fine to medium grain sand |
| | 60.5-73 | Fat clay, organic matter in bottom half |
| | 73-76.5 | Coarse grain sand with organic matter |
| #9 | 0-3 | Clayey silt |
| | 1.5 | Water table |
| | 3-6 | Silty clay |
| | 6-7.5 | Fat clay with sand lenses |
| | 7.5-9 | Fine to medium grain sand |
| | 9-13.5 | Very fine, silty sand |
| | 13.5-15 | No sample taken |
| | 15-18 | Marine-type fat clay |
| | 18-19.5 | No sample taken |
| | 19.5-21 | Marine-type fat clay with lenses of sand |
| | 21-31 | Fine to medium grain sand with organic matter |
| | 31-40.5 | Fat clay |
| | 40.5-42 | No sample taken |
| | 45-50 | Fat clay |
| | 50-51.5 | No sample taken |
| | 51.5-54.5 | Very fine, sandy clay |

Table 5 (continued). MTF LOGS OF BORINGS[a]

| | Soil sample depth, ft. | Description |
|---|---|---|
| #9 | 54.5-57.5 | Very fine, silty sand with slight clay content |
| | 57.5-59 | No sample taken |
| | 59-63.5 | Fine to medium grain sand |
| | 63.5-65 | No sample taken |
| | 65-68 | Fine to medium grain sand |
| | 68-69.5 | No sample taken |
| | 69.5-71 | Coarse grain sand with few pea gravel |
| | 71-72.5 | No sample taken |
| | 72.5-75.5 | Coarse grain sand with few pea gravel |
| #10 | 0-1.5 | Clayey, fine sand |
| | 1.5-4.5 | Sandy clay with lean clay lenses, fat clay lenses in bottom |
| | 4.5-6 | Fat clay with sand lenses |
| | 6-7.5 | Clayey sand with fat clay layer |
| | 7.5 | Water table |
| | 7.5-13.5 | Silty sand with some clay lenses |
| | 13.5-15 | Sandy clay with fat clay lenses and organic color |
| | 15-19.5 | Organic fat clay |
| | 19.5-24 | Fat clay with sand lenses |
| | 24-25.5 | Sandy clay stiff with fat clay lenses |
| | 25.5-28.5 | Clayey sand with sandy clay or silt lenses |
| | 28.5-30 | No sample taken |
| | 30-36 | Silty sand with trace organic matter, micaceous at bottom |
| | 36-37.5 | Poorly graded sand |
| | 37.5-39 | Silty sand with layer of clayey sand |
| | 39-49.5 | Poorly graded sand, some organic color |
| | 49.5-51 | No sample taken |
| | 51-54 | Organic fat clay with sandy clay layer, wood fiber present |
| | 54-55.5 | Silty sand with clay layers |
| | 55.5-64.5 | Poorly graded sand with pea gravel at bottom |
| | 64.5-67.5 | Gravel/sand mixture |
| | 67.5-75 | Poorly graded sand with some pea gravel |
| #11 | 0-1.5 | Clayey fine silt with silty sand in lower portion |
| | 1.5-3 | Silty sand, slightly micaceous |
| | 3-6 | Clayey sand with silty sand layers |
| | 6-7.5 | Silty sand |
| | 7.5-9 | No sample taken |
| | 9 | Water table |
| | 9-10.5 | Clayey silt with fine sand lenses |
| | 10.5-22.5 | Fat clay, iron oxide and organic matter at top, sand lenses and sandy clay at bottom |
| | 22.5-24 | Poorly graded sand with few clay lenses and chips undecayed wood |
| | 24-28.5 | Fat clay with layers of highly plastic silty clay |
| | 28.5-45 | Silty sand with clay layers and micaceous |
| | 45-57 | Poorly graded sand, clay at top, gravel at bottom |

Table 5 (continued). MTF LOGS OF BORINGS[a]

| | Soil sample depth, ft. | Description |
|---|---|---|
| #11 | 57-60 | Silty sand with trace of mica |
| | 60-61.5 | Poorly graded sand |
| | 61.5-63 | Clayey sand with sand layers |
| | 63-64.5 | Poorly graded sand with clay lenses |
| | 64.5-66 | Silty clay with very fine sand layers and trace organic matter |
| | 66-70.5 | Fat clay with trace organic matter |
| | 70.5-72 | Sandy clay with fat clay lenses and some organics |
| | 72-73.5 | Silty sand with trace of clay |
| | 73.5-75 | Poorly graded sand with trace of clay |
| #12 | 0-1 | Very soft, sandy clay |
| | 1 | Water table |
| | 1-6 | Sandy clay |
| | 6-9 | Clayey sand |
| | 9-10.5 | Fine to medium grain sand with slight clay content |
| | 10.5-12 | Very fine, silty sand |
| | 12-15 | Very fine, clayey silt |
| | 15-24 | Fat clay with layers of organic matter, some sand at bottom |
| | 24-25.5 | Very fine, sandy clay |
| | 25.5-27 | Very fine, sandy silt, micaceous |
| | 27-28.5 | Clayey sand |
| | 28.5-31.5 | Coarse grain sand, with layers of clay |
| | 31.5-48 | Fine to medium grain sand, organic matter at top |
| | 48-60 | Fat clay, clayey silt at top, sand layers center |
| | 60-61.5 | Organic fat clay |
| | 61.5-69 | Fat clay, slight sand content with layer or organic matter at bottom |
| | 69-70.5 | Sandy clay |
| | 70.5-75.5 | Fat clay with slight sand content |
| | 75.5-80 | Very fine, silty sand |
| #13 | 0-3 | Very fine clayey silt |
| | 1.5 | Water table |
| | 3-7.5 | Silty clay going to sandy clay |
| | 7.5-10.5 | Fine to medium grain sand with slight clay content |
| | 10.5-12 | No sample taken |
| | 12-15 | Very fine sandy silt, organic matter at bottom |
| | 15-22.5 | Fat clay |
| | 22.5-24 | Very fine silty sand with trace of clay |
| | 24-25.5 | Silty clay |
| | 25.5-27 | Fat clay |
| | 27-28.5 | Clayey silt |
| | 28.5-30 | Silty clay |
| | 30-34.5 | Clayey silt going to sandy silt |
| | 34.5-42 | Silty sand with clay lenses at top |
| | 42-55.5 | Fine to medium grain sand, some organics |
| | 55.5-57 | Sandy clay |

Table 5 (continued). MTF LOGS OF BORINGS[a]

| | Soil sample depth, ft. | Description |
|---|---|---|
| #13 | 57-58.5 | Fat clay with sand layers |
| | 58.5-60 | Organic fat clay |
| | 60-63 | Sandy clay |
| | 63-66 | Silty sand |
| | 66-69 | Fine to medium grain sand |
| | 69-73.5 | Coarse grain sand |
| | 73.5-75 | Fine to medium grain sand |
| #14 | 0-3 | Clayey silt |
| | 3-9 | Silty clay with sand going to sandy clay with silt |
| | 9.5 | Water table |
| | 9-36 | Poorly graded sand, with pea gravel getting more extensive towards bottom |
| | 36-40.5 | Fat clay with sand lenses and organic matter |
| | 40.5-42 | Silty clay with fine sand lenses |
| | 42-45 | Fat clay with fine sand lenses |
| | 45-51 | Sandy to lean clay, with silt, micaceous |
| | 51-55 | Fat clay |
| | 55-57.5 | Organic fat clay |
| | 57.5-59 | Clayey fine sand with few pieces organic matter |
| | 59-66.5 | Fat clay with some organic matter, sandy at bottom |
| | 66.5-70 | No sample taken |
| | 70-77.5 | Poorly graded sand |
| #15 | 0-1.5 | Silty sand |
| | 1.5-7.5 | Lean to sandy clay, with fat clay, iron oxide and mica |
| | 7.5-13.5 | Silty sand, micaceous |
| | 11 | Water table |
| | 13.5-19.5 | Fat clay with organic layers at bottom |
| | 19.5-21 | No sample taken |
| | 21-24 | Silty sand with trace of clay and mica |
| | 24-27 | Sandy clay with layers of clayey sand and some organic content |
| | 27-30 | Lean clay with sand content, clay very plastic |
| | 30-36 | Silty sand, micaceous |
| | 36-61.5 | Fat clay with silt and sand lenses |
| | 61.5-64.5 | Sandy clay with organic coloring |
| | 64.5-72 | Fat clay with sand lenses and organic coloring |
| | 72-73.5 | Poorly graded sand |
| | 73.5-75 | Silty sand with clay lenses |
| | 75-88.5 | Poorly graded sand, pea gravel at bottom |
| | 88.5-93 | Gravel and sand mixture |
| | 93-106.5 | Poorly graded sand with trace of clay and pea gravel going to gravelly sand |
| | 106.5-111 | Gravel/sand mixture |
| | 111-115.5 | Poorly graded sand with numerous pea gravel |
| | 115.5-120 | Silty sand |

## Table 5 (continued). MTF LOGS OF BORINGS[a]

| | Soil sample depth, ft. | Description |
|---|---|---|
| #15 | 120-133.5 | Poorly graded sand, gravelly in center |
| | 133.5-139.5 | Fat clay with sand and silt lenses |
| | 139.5-163.5 | Silty clay with fat clay layers |
| | 163.5-168 | Fat clay, stiff with small sand content |
| | 168-175.5 | Silty clay with fat clay and sand lenses |
| | 175.5-180 | Sandy silt |
| | 180-184.5 | Extremely fine sandy clay |
| | 184.5-186 | No sample taken |
| | 186-192 | Extremely fine sandy clay |
| | 192-201 | Clayey silt to sandy silt |
| | 201-210 | Lean clay with sand |
| | 210-214.5 | Extremely fine clayey sand |
| | 214.5-219 | Extremely fine clayey silt |
| | 219-231 | Silty sand with slight clay content and organic stain |
| | 231-234 | Clayey silt with layers of silty sand |
| | 234-241.5 | Silty sand with slight clay content |
| | 241.5-250.5 | Silty clay, micaceous |
| | 250.5-253.5 | Sandy silt |
| | 253.5-256.5 | No sample taken |
| | 256.5-261 | Extremely fine silty sand |
| | 261-264 | No sample taken |
| | 264-285 | Extremely fine silty sand |
| | 285-295 | Silty clay with silty sand layers, micaceous |
| | 295-300 | Silty sand |
| #16 | 0-3 | Clayey silt |
| | 1.2 | Water table |
| | 3-7.5 | Lean to sandy clay |
| | 7.5-9 | No sample taken |
| | 9-15 | Silty sand |
| | 15-16.5 | Fat clay with organic matter |
| | 16.5-19.5 | Organic, fat clay |
| | 19.5-21 | Fat clay with organic matter |
| | 21-24 | Silty sand with organic matter at top |
| | 24-25.5 | Organic, fat clay with sand lenses |
| | 25.5-27 | Silty sand with layers organic matter |
| | 27-28.5 | Partially decomposed wood with sand lenses |
| | 28.5-33 | Sandy clay |
| | 33-61.5 | Fat clay |
| | 61.5-63 | Organic, fat clay |
| | 63-66 | Fine, clayey sand |
| | 66-67.5 | Silty sand |
| | 67.5-69 | Fine to medium grain sand with layer of clay |
| | 69-70.5 | Silty sand |
| | 70.5-72 | Coarse sand with few gravel |
| | 72-75 | Fine to medium grain sand with clay stain and traces of clay |

Table 5 (continued). MTF LOGS OF BORINGS[a]

| | Soil sample depth, ft. | Description |
|---|---|---|
| #17 | 0-1.5 | Clayey silt |
| | 1.5-7.5 | Sandy clay with clayey sand layers and fat clay lenses |
| | 8 | Water table |
| | 7.5-15 | Silty sand, slightly micaceous |
| | 15-16.5 | Micaceous, clayey silt with very fine sand |
| | 16.5-27 | Fat clay with some organic matter and sand lenses |
| | 27-30 | Clayey fine sand with silt lenses, slightly micaceous |
| | 30-34.5 | Silty sand with trace mica |
| | 34.5-36 | Sand |
| | 36-39 | Silty sand |
| | 39-42 | Organic material, partially decayed log |
| | 42-58.5 | Fine to medium grained sand |
| | 58.5-66 | Silty sand |
| | 66-68.5 | Fine to medium grain sand |
| | 68.5-72 | Coarse sand with few pea gravel |
| | 72-78 | Silty sand with some organic matter |
| | 78-81 | Fine to medium grain sand with few pea gravel |
| | 81-83.5 | Coarse grained sand with pea gravel |
| | 83.5-85.5 | Fat clay |
| | 85.5-87 | Sandy clay with fat clay lenses |
| | 87-100.5 | Fat clay with silty clay layers, some chalky, weathered pebbles |
| | 100.5-107 | Silty clay with fat clay lenses |
| | 107-109.5 | Very fine, clayey sand |
| | 109.5-117 | Very fine, silty sand, micaceous with slight clay content |
| | 117-160.5 | Silty clay, to lean clay, to sandy clay, with organic matter towards bottom |
| | 160.5-167.5 | Clayey, fine sand |
| | 167.5-173 | Sandy clay |
| | 173-176 | Clayey sand |
| | 176-182 | Lean clay |
| | 182-193 | Silty sand, slight clay content towards bottom |
| | 193-196 | Fat clay with layers of sand |
| | 196-197 | Very fine, silty sand |
| | 197-219.5 | Silty clay with sand lenses and mica, lean clay at bottom |
| | 219.5-228 | Clayey silt to sandy silt |
| | 228-237 | Lean to sandy to silty clay |
| | 237-238.5 | Very fine, clayey sand |
| | 238.5-257 | Lean to silty clay with sand lenses |
| | 257-266 | Fat clay with silty clay and sand lenses |
| | 266-267.5 | Fine to medium grain sand |
| | 267.5-270 | Clayey silt |
| | 270-273 | Sandy clay |
| | 273-300 | Silty sand with slight clay content |

## Table 5 (continued). MTF LOGS OF BORINGS[a]

| | Soil sample depth, ft. | Description |
|---|---|---|
| #18 | 0-7.5 | Clayey sand with silt lenses |
| | 8 | Water table |
| | 7.5-13.5 | Sand/silt mix, with some clay layers and mica |
| | 13.5-16.5 | Organic fat clay |
| | 16.5-18 | Wood, apparently root |
| | 18-19.5 | No sample taken |
| | 19.5-21 | Fat clay |
| | 21-22.5 | No sample taken |
| | 22.5-27 | Sandy clay |
| | 27-28.5 | Clayey sand with lenses of sandy clay |
| | 28.5-31.5 | Sandy clay with lean and fat clay layers |
| | 31.5-34.5 | Fat clay with sand lenses and trace organic matter |
| | 34.5-36 | Silty clay with fat clay layer |
| | 36-42 | Fat clay with sand lenses |
| | 42-46.5 | Sandy clay, with trace silt at bottom |
| | 46.5-52.5 | Silty sand with trace mica |
| | 52.5-69 | Poorly graded sand |
| | 69-70.5 | Gravel/sand mixture |
| | 70.5-75 | Poorly graded sand, pea gravel at bottom |
| #19 | 0-3 | Clayey sand |
| | 3-7.5 | Lean clay |
| | 7.5-15 | Silty sand |
| | 15-18 | Fat clay |
| | 18-19.5 | Organic clay |
| | 19.5-21 | Silty, clayey sand |
| | 21-22.5 | Clayey sand |
| | 22.5-27.5 | Silty sand |
| | 27.5-33 | Fat clay, sandy towards bottom |
| | 33-34.5 | Silty sand |
| | 34.5-42.9 | Sand |
| | 42.9-49.5 | Silty sand |
| | 49.5-50.5 | Sand |
| | 50.5-52.5 | Clayey sand |
| | 52.5-54 | No sample taken |
| | 54-55.5 | Clayey sand |
| | 55.5-57 | Silty sand |
| | 57-74.8 | Sand, gravel at some spots |
| #20 | 0-7 | Sandy clay |
| | 1 | Water table |
| | 7-13 | Silty sand |
| | 13-16 | Clayey sand |
| | 16-27.5 | Fat clay (in lower third, slightly organic with decayed wood). |
| | 27.5-29 | Silty sand |
| | 29-30.5 | Poorly graded, silty sand |
| | 30.5-33.5 | Poorly graded sand |

Table 5 (continued). MTF LOGS OF BORINGS[a]

| | Soil sample depth, ft. | Description |
|---|---|---|
| #20 | 33.5-42.5 | Poorly graded, silty sand |
| | 42.5-51.5 | Poorly graded sand with fat clay, leading to pea gravel, leading to pea gravel with decayed wood |
| | 51.5-58.5 | Clayey sand |
| | 58.5-60.5 | Sandy, fat clay |
| | 60.5-62 | No sample taken |
| | 62-79.5 | Sandy, fat clay with spots of decayed wood |
| | 79.5-81.5 | Poorly graded sand with pea gravel |

[a] U.S. Army Corps of Engineers, Savannah, Georgia (1963).

Table 6 . MTF POTABLE AND INDUSTRIAL GEOCHEMICAL DATA[a]
(Well Points Located on Figure 28)

| Well #[b] | A[c] | B | C | D | E | F | G | H | I[d] | J | K | L | M | N | O | P | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | 7 | 11.0 | 16 | .2 | .2 | 236 | 5 | 8.95 | 10 | 1460-1524 | 20 | .04 | 1.9 | .1 | 86 | 1.1 | 186 |
| 32 | 7 | 13.0 | 19 | .2 | .2 | 236 | 5 | 8.95 | 10 | 1405-1480 | 20 | .09 | 2.0 | .0 | 85 | 1.3 | 178 |
| 35 | 0 | 11.0 | 13 | .3 | .0 | 253 | 5 | 8.95 | 5 | 1345-1435 | 20 | .02 | 0.8 | .7 | 97 | 1.2 | 221 |
| 34 | 0 | 7.6 | 22 | .4 | .2 | 315 | 7 | 8.75 | 5 | 1800-2000 | 35 | .05 | 2.5 | .2 | 115 | 2.0 | 268 |
| 37 | 0 | 11.0 | 26 | .3 | .0 | 262 | 5 | 8.45 | 10 | 1580-1730 | 21 | .12 | 2.0 | .0 | 97 | 1.0 | 211 |
| 36 | 0 | 4.6 | 20 | .3 | .0 | 263 | 4 | 9.1 | 10 | 455-675 | 8.1 | .23 | 0.7 | .5 | 106 | 0.8 | 248 |

---

[a] Modified from Newcome (1967).

[b] Well descriptions: 33, potable-water well no. 1; 32, potable-water well no. 2; 35, Saturn V potable-water well; 34, industrial well no. 1; 37, industrial well no. 2; 36, industrial well no. 3; see Key to Table 6 on next page.

[c] Concentration in ppm (parts per million).

[d] Expressed in terms of Hazen Pt-Co scale.

## KEY TO TABLE 6 COLUMN HEADINGS

A - Carbonate ($CO_3$)
B - Sulfate ($SO_4$)
C - Chloride (Cl)
D - Fluoride (F)
E - Nitrate ($NO_3$)
F - Dissolved Solids
G - Hardness as $CaCO_3$
H - pH
I - Color
J - Water-Bearing Interval (in ft.)
K - Silica ($SiO_2$)
L - Iron (Fe)
M - Calcium (Ca)
N - Magnesium (Mg)
O - Sodium (Na)
P - Potassium (K)
Q - Bicarbonate ($HCO_3$)

## TABLE 7 RECORDS OF MISSISSIPPI TEST FACILITY WATER WELLS[1]

| Well No.[2] | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| 33 | 1,524 | 1464-1524 | 90 | 28 | -- | 2,487 | 89 | --- | --- |
| 32 | 1,481 | 1418-1481 | 86 | 14 | -- | 1,089 | -- | --- | --- |
| 35 | 1,873 | 1803-1873 | 104 | 12 | 45 | 3,550 | 100 | 100,000 | 550 |
| 34 | 1,434 | 1371-1434 | 81+ | 15 | 60-80 | 1,218 | 91 | 81,000 | 930 |
| 37 | 1,695 | 1585-1695 | 90 | 26 | 30 | 5,000 | 96 | 200,000 | 1,670 |
| 36 | 672 | 458-494<br>532-580<br>616-672 | 15 | 47 | 95 | 5,865 | 79 | 116,000 | 685 |

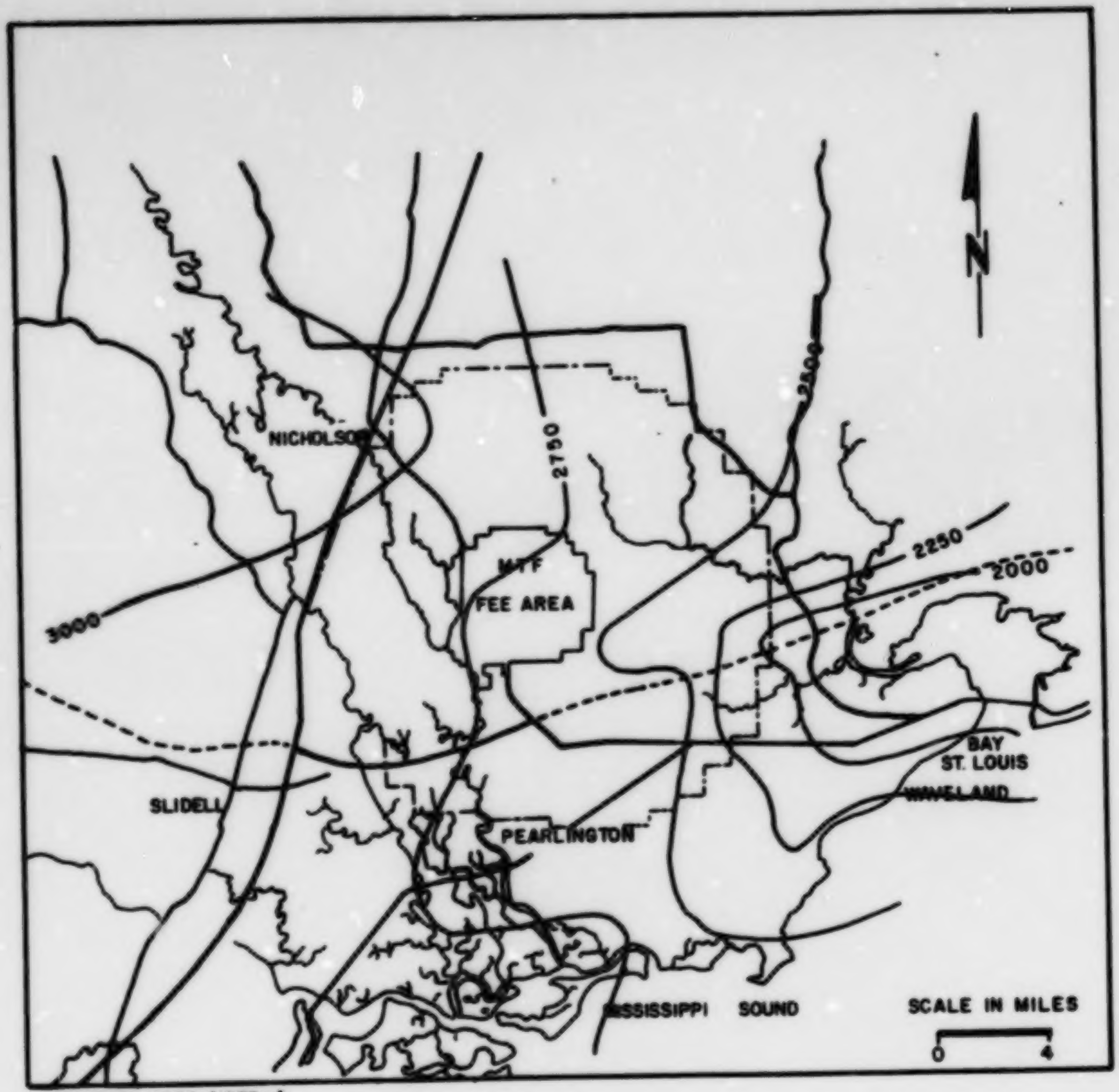
---

[1] Newcome, 1967.

[2] Well descriptions: 33, potable-water well no. 1; 32, potable-water well no. 2; 35, industrial well no. 1; 34, Saturn V potable-water well; 37, industrial well no. 2; 36, industrial well no. 3. Well numbers 33 and 32 are located in Administration Area; well numbers 35, 34, 37, and 36 are located in Test Area.

KEY:

A - Depth (in ft.)
B - Interval (in ft.)
C - Static Water Level (ft. above land surface)
D - Specific Capacity (gpm/ft. of drawdown)
E - Well Efficiency (%)
F - Production on Test (gpm)
G - Temperature (° F.)
H - Coefficient of Transmissibility (gpd/ft.)
I - Coefficient of Permeability (gpd/sq. ft.)



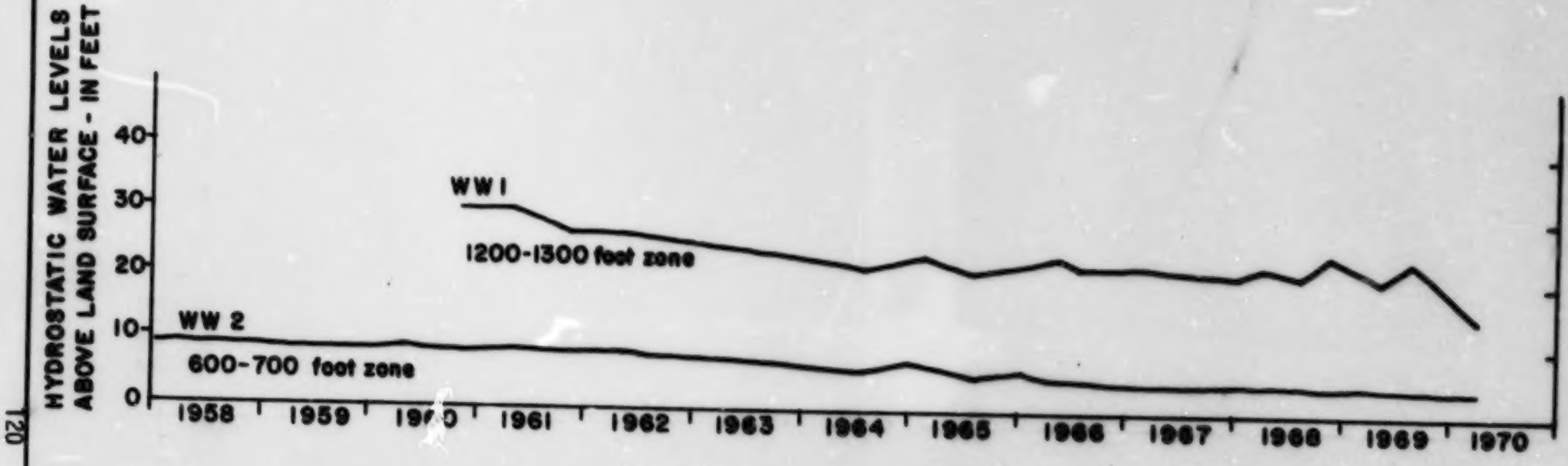
MODIFIED USGS (1970e)

CONTOUR INTERVAL: 250 feet

DEPTH TO BASE OF FRESHWATER 2000 feet

DEPTH TO FRESH/SALINE WATER INTERFACE

Figure 29

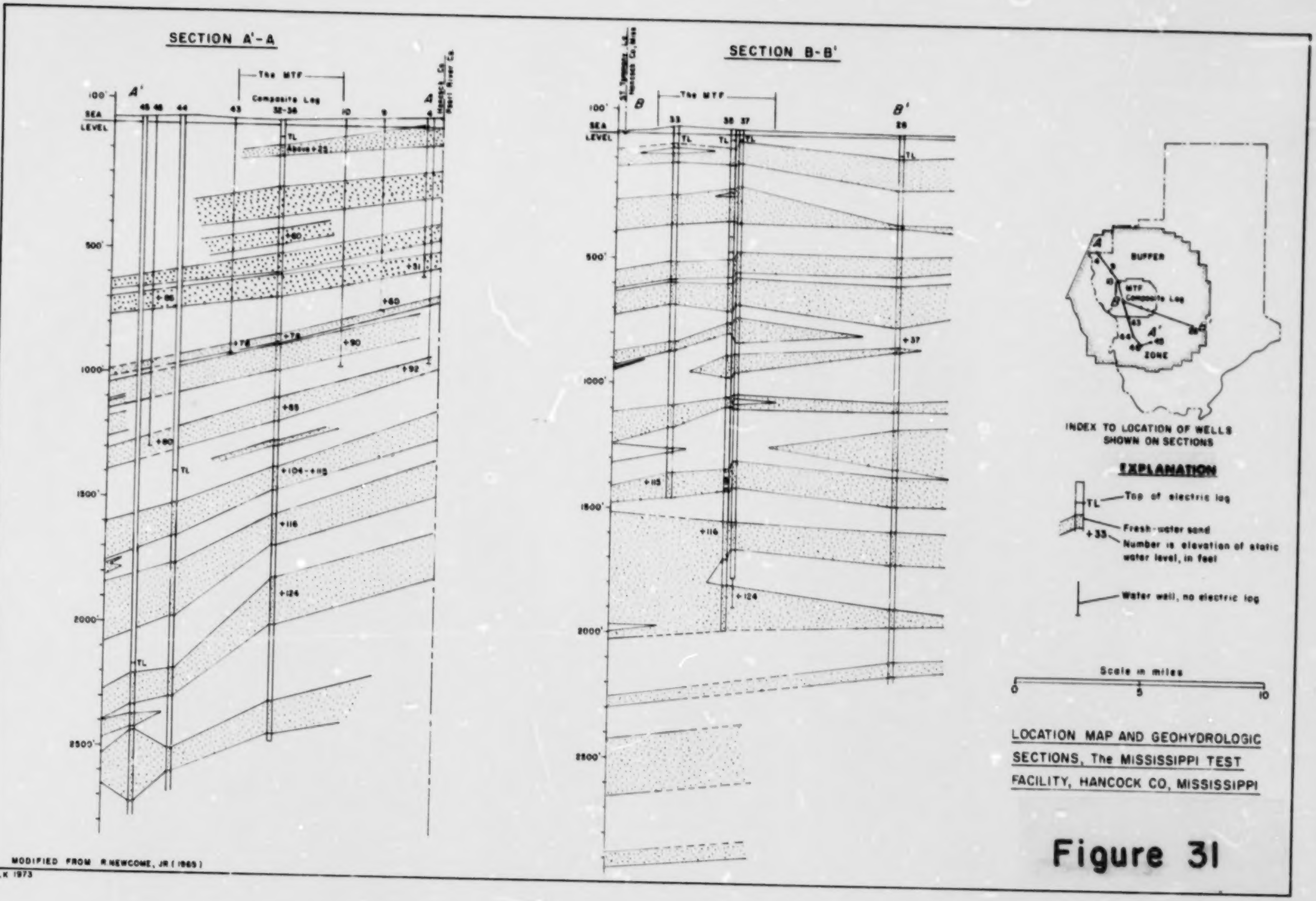


WW 1 - WATER WELL, CITY OF BAY ST. LOUIS, DRILLED 1910
WW2 - WATER WELL, STATE OF MISS. HIGHWAY DEPT., DRILLED 1938

Modified from Gulf Regional Planning Commission (1972)

Figure 30

GROUND WATER LEVELS - BAY ST. LOUIS & WAVELAND AREAS
HANCOCK COUNTY, MISSISSIPPI



MODIFIED FROM R. NEWCOME, JR (1965)

CLK 1973

LOCATION MAP AND GEOHYDROLOGIC SECTIONS, The MISSISSIPPI TEST FACILITY, HANCOCK CO, MISSISSIPPI

Figure 31

Several drilled wells of the MTF have been used to define the hydraulic potentiometric surface (surface to which water in an aquifer would rise) of certain subsurface aquifers. Figure 32 illustrates these potentiometric surface values and indicates the following:

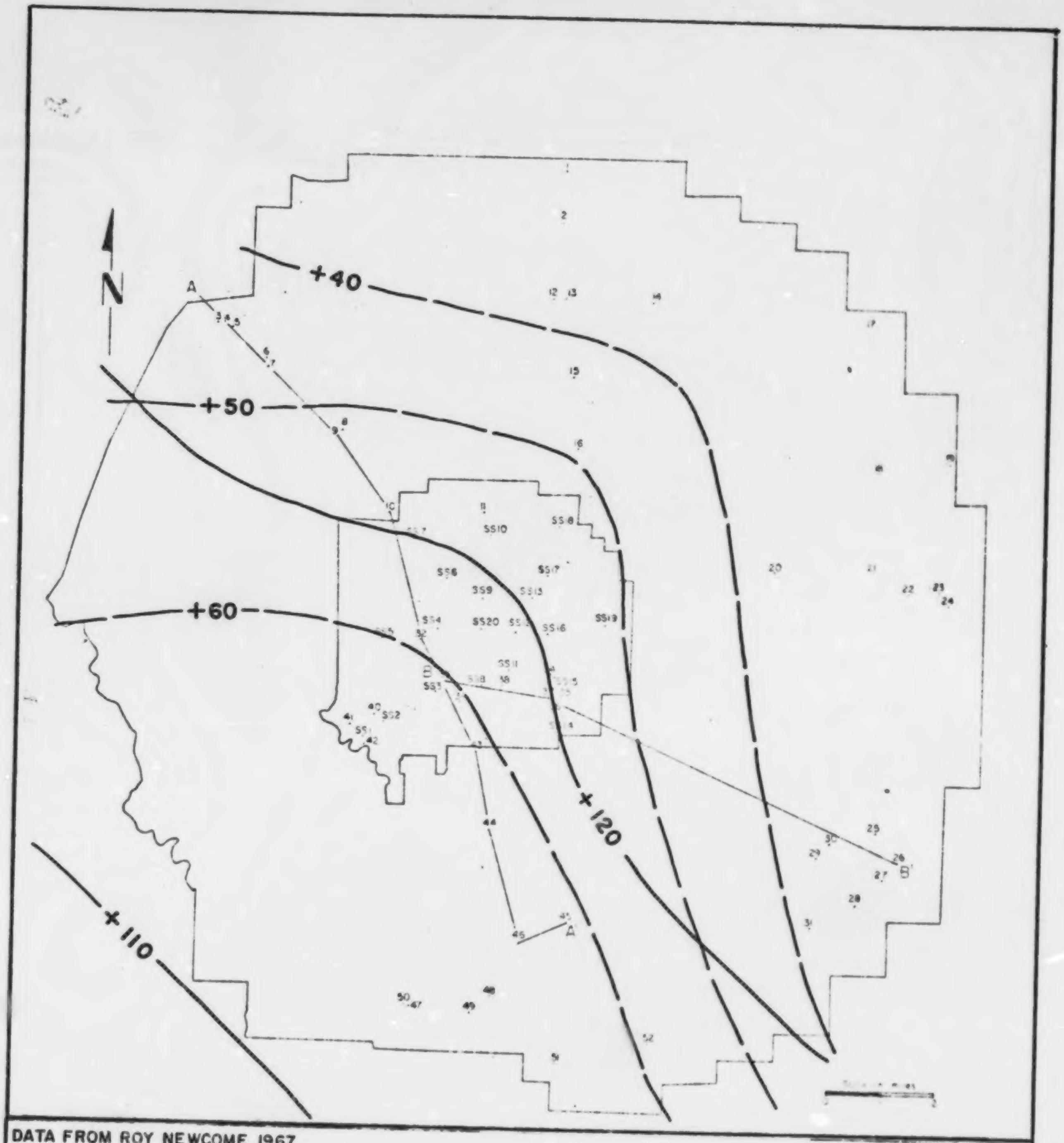
1) The intermediate flow system is governed by the mixed sediments overlying the regional flow system.

2) The intermediate flow system is also hydrodynamically more sluggish then the regional flow system, which is governed by the deltaic floodplain of the Pearl River and by the headwater sediments of the Jourdan and Bayou La Croix basins.

3) The local flow system is governed by the soil characteristics located on the topographic highs and lows in the immediate vicinity of the MTF (these flow velocities vary proportionately with the hydraulic conductivities of the various known soil types of southwest Mississippi).

The interrelated characteristics of the three flow systems have been defined in various degrees of detail. The regional flow system has been defined adequately by previous investigators, but the hydraulic contribution of the intermediate (Citronelle formation groundwater flow) and local flow systems (Recent sediment flow system) have been only partially outlined and defined. In order to get a better quantified understanding of the intermediate and local flow systems, various studies would have to be performed and the data interrelated (multivariant analyses) to form the total hydrologic model. It is suggested that detailed studies of all major surface drainage systems include monitoring to determine interflow, runoff, and baseflow characteristics. The hydrologic data collected along with the simultaneous collection of climatological and evapo-transpirational data would give information about needed water volumes contributed and subtracted from the local water budget. With synthesis of the hydrologic data and the incorporation of a runoff model (see Figure 33), the local system could be quantified and accurately defined mathematically.

In order to monitor various facets of two flow systems, an intricate set of well points and piezometers should be installed to determine water table fluctuations. This information would also aid in supplying a sampling site for determination of subsurface water quality. The use of modified-random piezometer locations would help to determine the volume and rate of recharge and discharge at various locations in the MTF site. The well system could also provide the necessary on-going monitoring stations for the observation of rate of potential contamination from the proposed HMSE Facility.



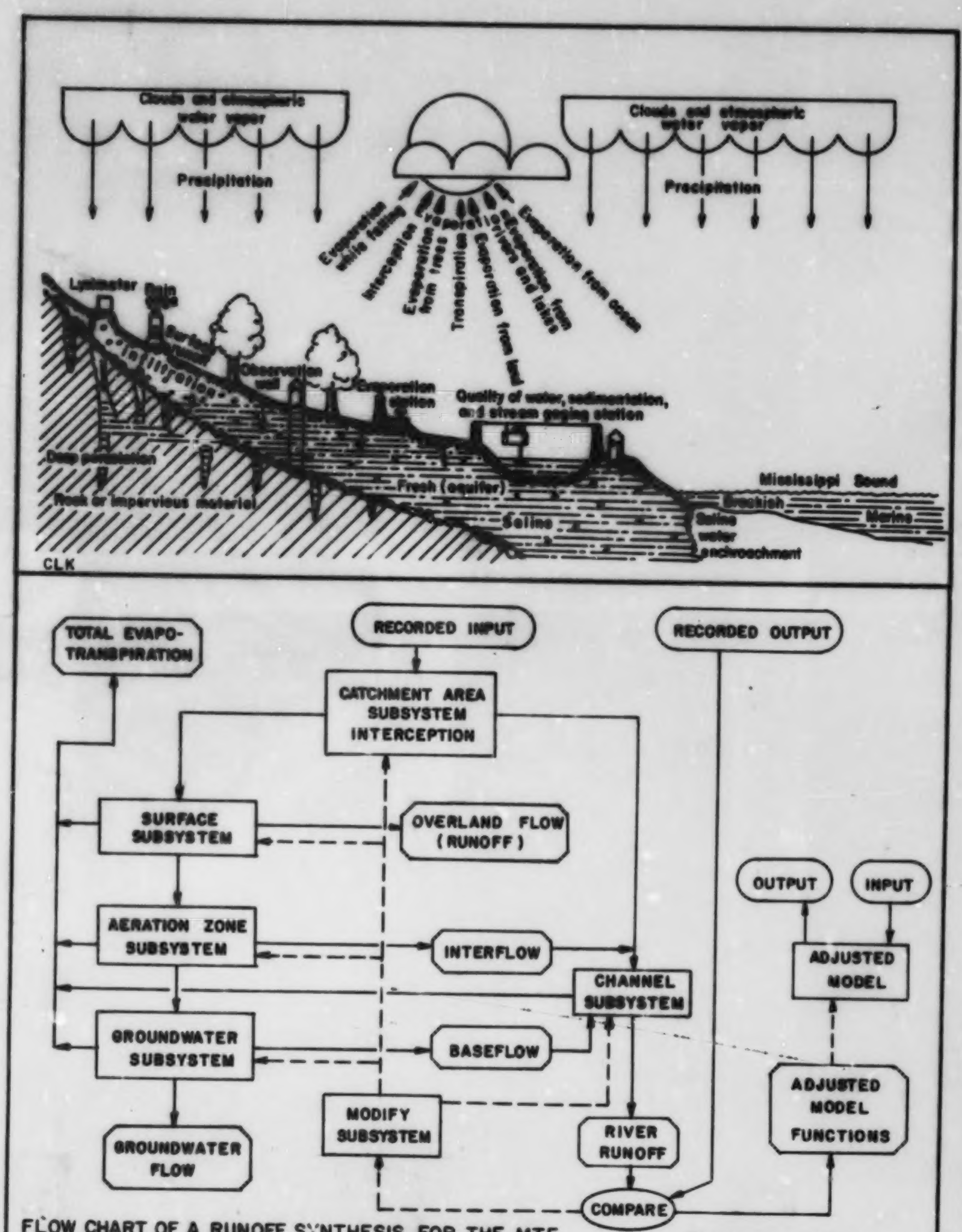
DATA FROM ROY NEWCOME, 1967

**LEGEND**

1-52 DEEP PENETRATING WELLS
SS1-SS20 SOIL SAMPLING SITES
—— AQUIFER 1500'-2000' DEPTH
— — AQUIFER 1000'-1500' DEPTH

STATIC WATER LEVEL INTERVAL = 10'
( DATA FROM NEWCOMBE 1967 )

POTENTIOMETRIC MAP - THE MTF Figure 32



FLOW CHART OF A RUNOFF SYNTHESIS FOR THE MTF, PEARL & JOURDAN DRAINAGE BASINS

Figure 33

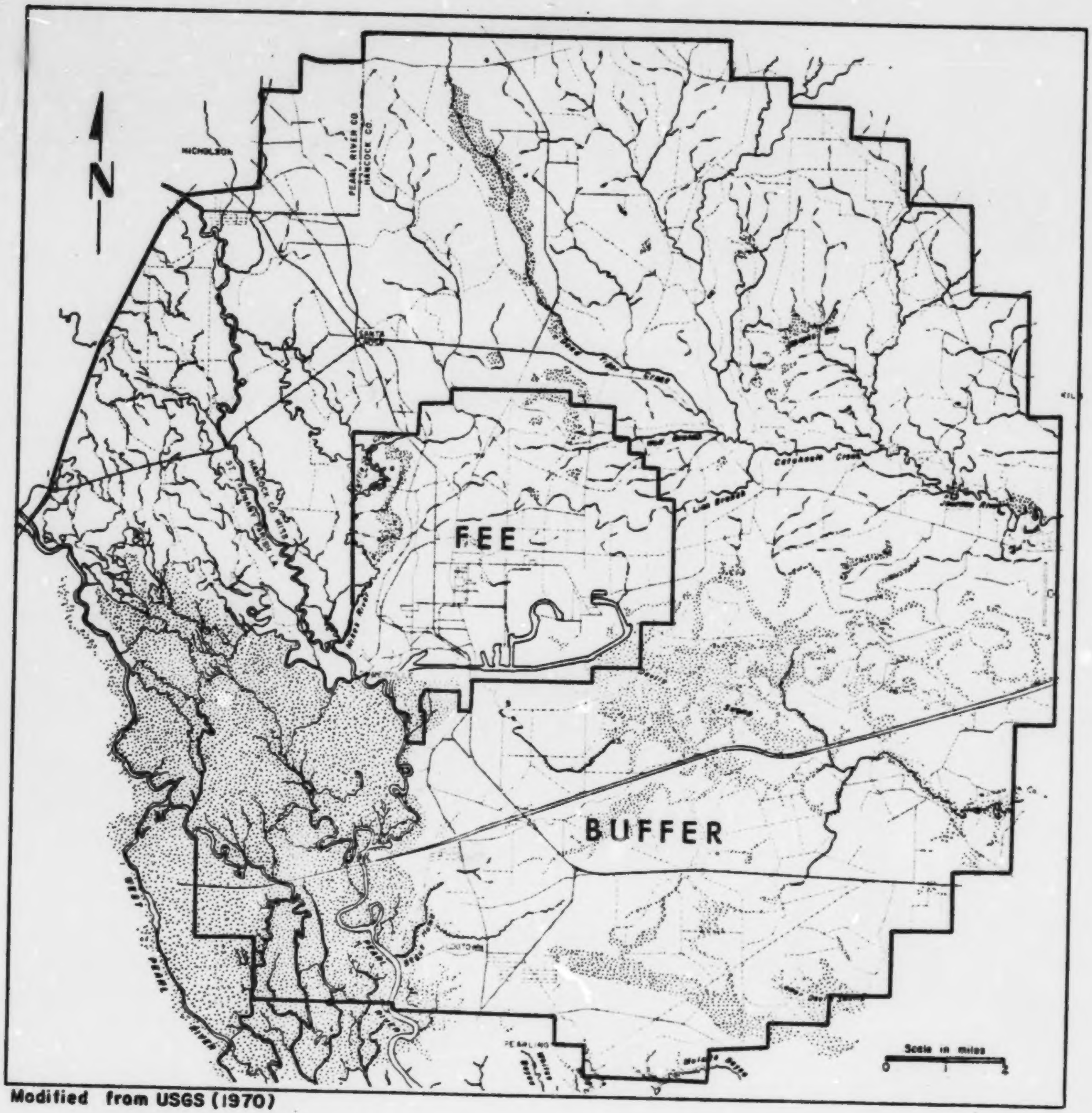
In summary, the hydrologic model could be devised by using various on-site individual investigations as well as system analyses, in coordination with detailed, complete determinations of the many distributed parameters. Again, a schematic flow model would be needed to research the hydrologic budget; such as presented in Figure 33.

## Surface Drainage

The surface drainage patterns (Figure 34) indicate some indirect relationships of groundwater/surface water interaction. The Cypress Swamps in southern Mississippi indicate areas of discharge zones for local and/or regional groundwater flow systems which merge to form either saturated or ponded areas. The size, shape and characteristics of the discharge is dependent on topographic position, soils, drainage systems, vegetation and geology. The Hancock County area is located such that high hydrostatic pressures in the regional aquifers promote these poorly-drained surface conditions. Although the pressures are partially dissipated by the thick overlying deltaic sedimentary sequences, low-value hydraulic pressures are often released in shallow water systems by: 1) water forced vertically through the upper confining layer of the aquifer, and 2) discharging into low-lying topographic areas. The upper surfaces of these discharged waters prevent any downward migration of ponded surficial water. The significance of having these areas with aquifer pressures in soils of low permeability means the chances of serious contamination of deep aquifers in the MTF Fee and Buffer Areas are low, should an open system HMSE program be initiated.

The present drainage plus other interrelated and detailed surface hydraulic factors should also be taken into consideration. The present MTF site is, for the most part, located in the Pearl River drainage basin. The consequences of this location are that an estuarine/bayou environment extends as far inland as the site. The interaction of two different coastal environments (freshwater river and estuarine/bayou) necessitates constant monitoring to ensure: 1) that brackish water does not contaminate the normally fresh surface water supplies, and 2) that groundwater is not simultaneously or adversely polluted or otherwise affected. The constant monitoring of the three drainage basins would also ensure water quality monitoring of the MTF site, and would also monitor future urban and rural runoff (water quality) from areas in the mid to upper reaches of the Pearl and Jourdan Rivers. Similar monitoring of the poorly defined Bayou La Croix basin is also necessary. The delicate freshwater/brackish water interrelationships exist in all three systems.

The current hydrologic data program entails periodic chemical data collection along the course of the Pearl River and data collection at various gaging stations. The gaging stations used for definition of seasonal floods (and their hydrographs) are illustrated in



Modified from USGS (1970)

THE MTF DRAINAGE SYSTEMS

Figure 34

Figure 35. Figure 35a is a flood hydrograph monitored at Jackson, Mississippi, while Figure 35b represents discharge volume monitored at Bogalusa, Louisiana.

The magnitude of the two flood hydrographs illustrates the large seasonal volume fluctuations as illustrated by two peak volumes of 20,000 cfs. The volume of the magnitude produces stage heights ranging from 15-25 ft. in height. Stage heights of this magnitude have not been monitored as far south as the MTF site because of the lack of continuous stream monitoring stations. It is believed that stage heights of 21 ft. would inundate the Cypress swamp areas along the lower courses of the Pearl River. It is also believed that during periods of peak flooding, whether caused by spring floods, hurricanes or heavy rainfall, the poorly drained areas in the La Croix and Jourdan River basins would be also partially flooded if they are not properly managed. The possibility of a catastrophic event occurring in Southwest Mississippi either must be monitored first-hand or it must be extrapolated from past history. Figure 36 illustrates past effects of recent hurricanes on the coastal region as well as the extrapolated data of flood discharges of the Pearl River. To evaluate the total volumes, effects, and results of flood hazards, the environmental parameters must be critically evaluated on the four interrelated coastal environments (marine/brackish/freshwater/deltaic).

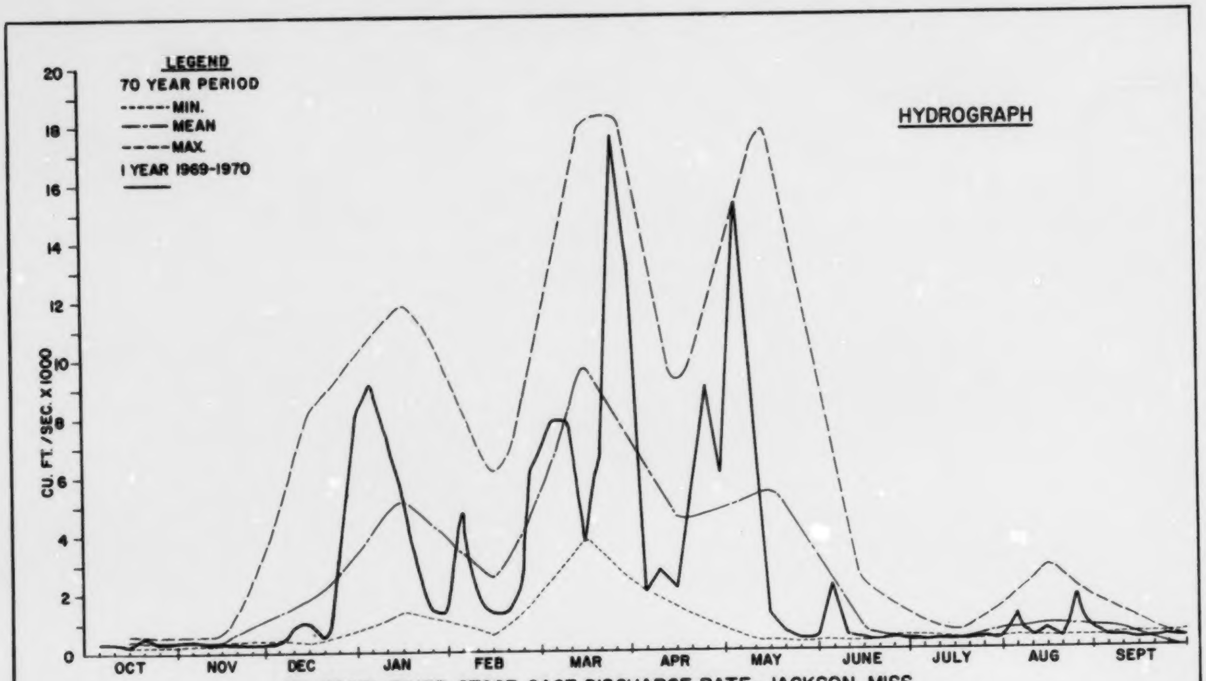
## Drainage Systems in the MTF Area

The Buffer Zone and Fee Area of the MTF are drained by the Pearl, La Croix and Jourdan River systems. The Pearl River and major drainage tributaries in the vicinity of the MTF are Turtleskin Creek, Mikes Creek, McCarty Bayou, Indian Camp Branch, Bogue Homa, and the MTF canal system.

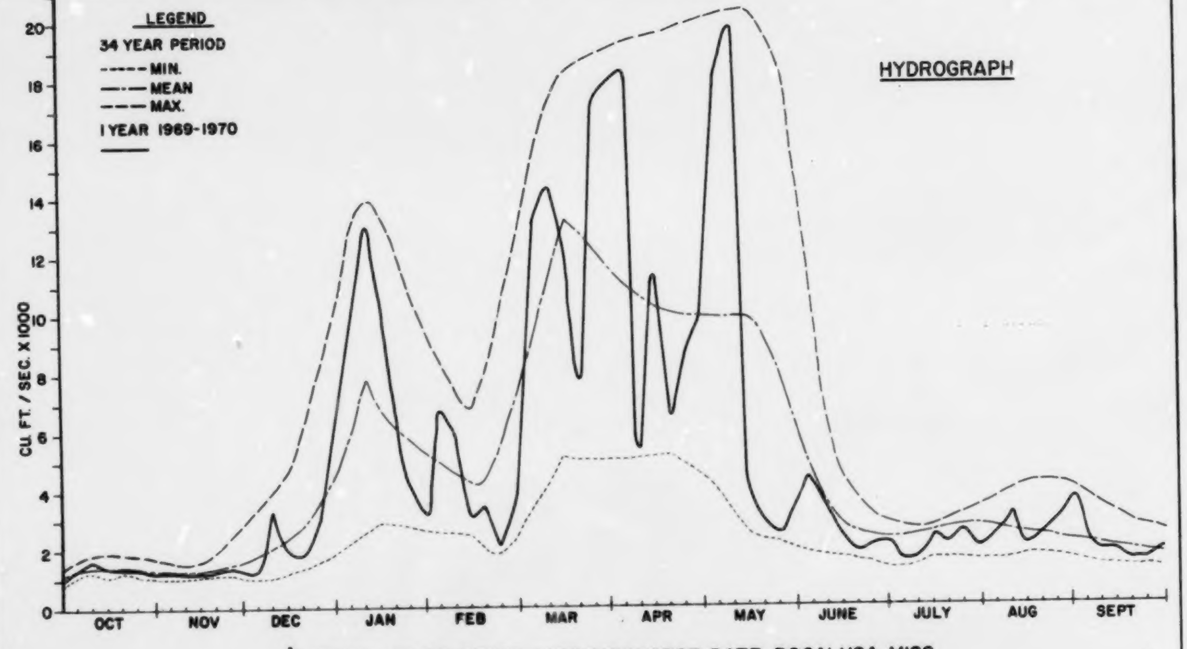
The canal system and associated Pearl River drainage has been improved to serve a dual purpose: 1) to drain the MTF, including much of Devil's Swamp, and 2) to serve as a waterway transportation system. The canal has an elevation of 18.0 ft. above mean sea level with an allowance for a drawdown to 17 ft. above mean sea level.

The Lion's Branch, Wolf Branch and Dead Tiger Creek are tributaries of the Catahoula River. These, coupled with the tributaries of Everett Branch, Crabgrass Creek, Mill Creek, Hurricane Creek, Pigeon Roost Branch, Joseph Bay and Aldgreen Creek, form the Jourdan River system. The Jourdan River empties into the Bay of St. Louis and subsequently into the Mississippi Sound.

The drainage areas in the southeast section of the MTF site are the Pate, Whites and Mulatto Bayous and part of Devil's Swamp. All of these empty into tributaries that form the Bayou La Croix, which empties into the Bay of St. Louis and thus into the Mississippi Sound.



a-PEARL RIVER STAGE GAGE DISCHARGE RATE- JACKSON, MISS.

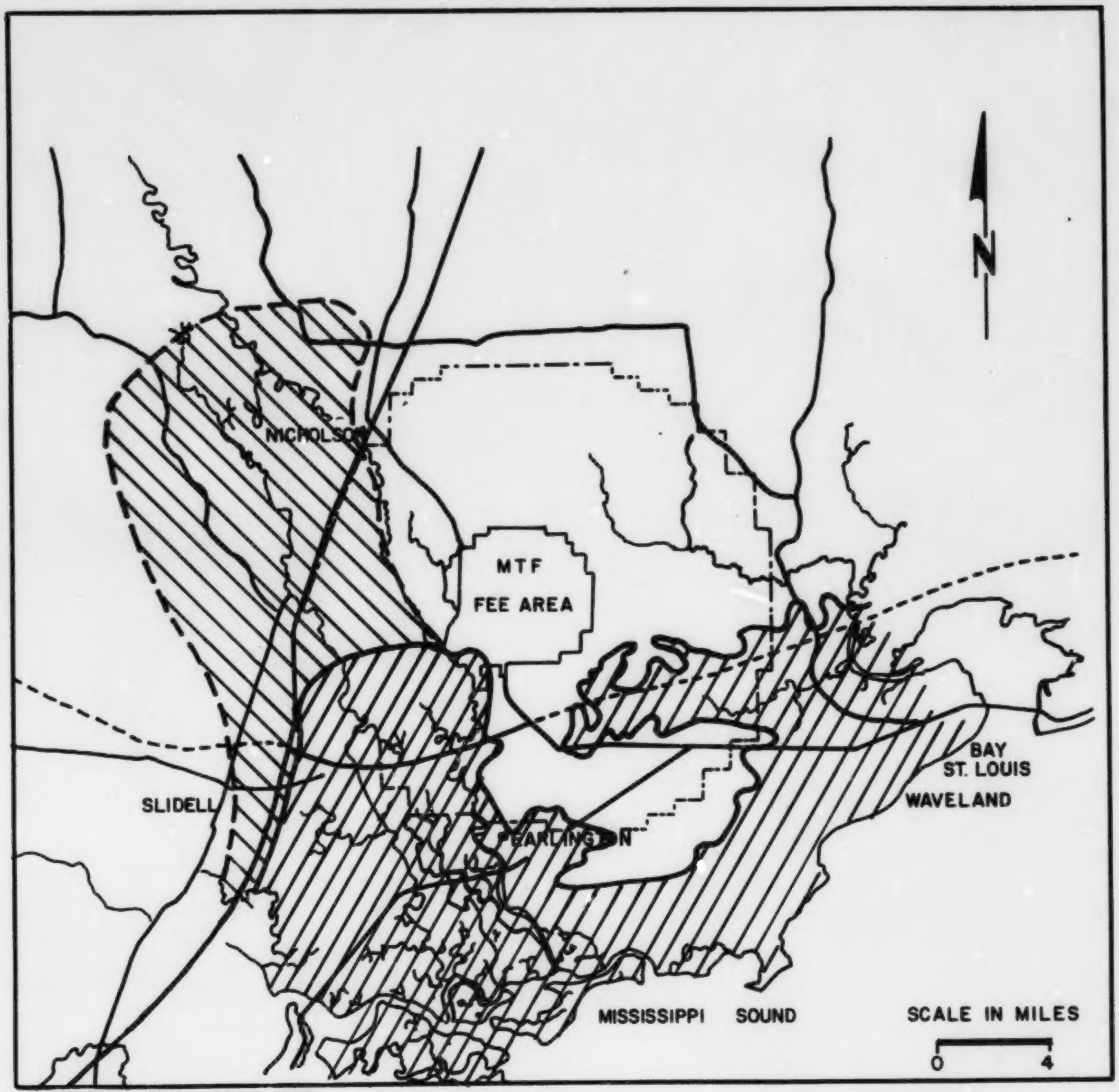


b-PEARL RIVER STAGE GAGE DISCHARGE RATE-BOGALUSA, MISS.

CLK

Data Modified From: USGS, 1970b

Figure 35



Modified from USGS, 1970a

▨ CAMILLE TIDAL / FLOOD LIMITS

▧ WATER QUALITY -- MODERATE TO SEVERE DEGRADATION EITHER TO CLIMATIC OR HUMAN IMPACT

KNOWN HURRICANE CAMILLE INFLUENCE ON SOUTHWEST MISSISSIPPI COASTAL REGION

Figure 36

Figure 34 illustrates these drainage systems.

## Coastal Environments in the MTF Area

Sediments in an aquatic environment parallel soil characteristics in a terrestrial environment. The Mississippi coastal sediments are brought in by varied depositional processes in varied coastal environments. The intricate interaction of the marine and terrestrial paludal environments is best illustrated by the geomorphic features present at the mouth of the Pearl River. Such features as deltas, tidal swamps, point bars, bayous, mudflats and cheniers contribute substantially to the heterogeneous deposits found in the Mississippi Sound coastal area.

Four coastal environments associated with the MTF area drainage systems need better definition, study and understanding: 1) the fluvial, 2) fluvial marine, 3) paludal, and 4) marine environments (Ref: Kolb and Van Lopik, 1966). Three major factors of the four coastal environments in the Hancock-Harrison Counties area are related to the fresh/brackish/marine water interfaces. The coastal ecosystem in Southwest Mississippi is normally subjected to extreme chemical and physical changes which subsequently determine the range and distribution of native aquatic and terrestrial biota.

The fluvial depositional process is geomorphically expressed in the forms of natural levees, point bars, and abandoned and active distributaries. These fluvial processes are subsurfacely expressed by sand and clay lines overlapping one another to form a complex, interfingering lithologic unit.

The fluvial-marine environment is represented by the pro-delta and intradelta, and interdistributary zones. These zones are produced where the stream's capacity to carry sediments is lowered because the high energy of the stream is dissipated in relatively low energy marine conditions. This lowered capacity, and the marine chemical interface, favors the deposition of coarse material landward with an increased deposition of fine clastics seaward.

Seasonal flooding favors deposition of fine flocculated sediments outside the major channel into what is termed the interdistributary zone. The interdistributary zone is represented in the Pearl River as poorly-drained, low areas populated variously with shoreline shrubs, coastal deciduous/evergreen species, various sedges, and a wide range of grasses. These clayey unconsolidated wedges in this zone grade seaward into pro-delta clays, grade landward into swamps or muck deposits, and grade laterally into major drainage passes (Ref: Fish, et al., 1954). The clays found in the interdistributary zones are segregated from pro-delta deposits only by utilizing the triaxial compression tests. These tests have shown that the pro-delta lean (inorganic) clayey deposits have higher strengths than the fat (organic) interdistributary clays. The purpose of describing these subtle differences is to emphasize that what appears to be pro-deltaic deposits under Hancock County, may partially be interdistributary fat clays.

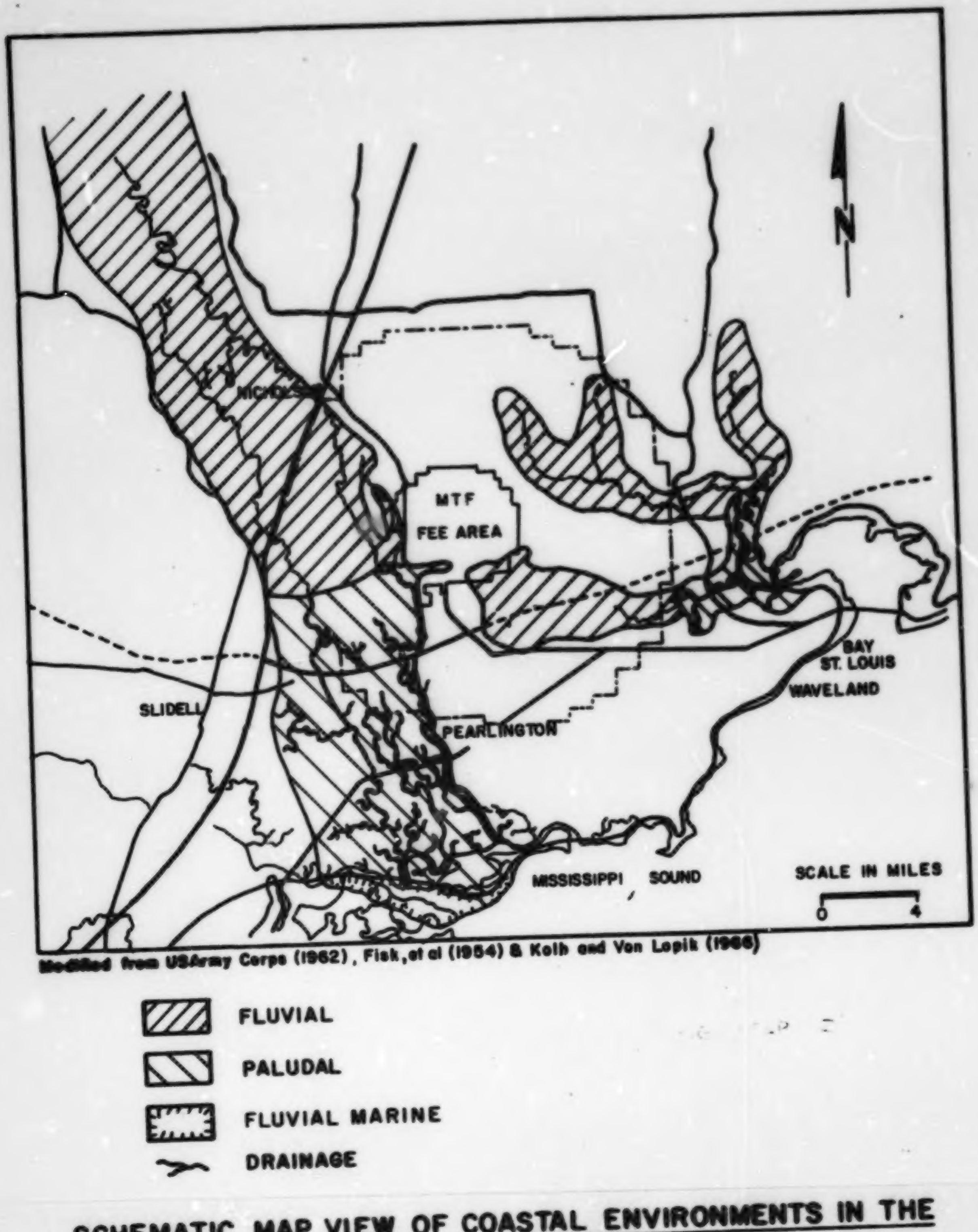
Pro-delta deposits grade seaward from silty clays into thick clay wedges. This separate zone of the marine/fluvial environment is geomorphically represented by mudflats, mud lumps, cheniers (beach deposits) and offshore bars. In addition, the intra-delta deposits associated with abandoned stream channels are sands, silts, and fine clastics which remain as sand wedges and "bar fingers" (Ref: U.S. Army Engineers, Waterways Experiment Station, 1962).

The paludal coastal environment refers to poorly-drained, shallow water, highly organic swamp, bayou and marsh environments. This zone borders between lacustrine (freshwater) and tidal channel deposits. The marshes in these areas are characteristically flat expanses of sedges and grasses. The drier sections of these grass/marsh expanses will be referred to as "wet prairie vegetation" while areas where tufts of grass are segregated by wet zones will be referred to as "marsh vegetation". The predominance of the marsh or prairie vegetation depends on the amount of subsidence, tidal influx, and salinity of water.

Marshy, organic, peaty, and anaerobic deposits have been segregated into separate units: 1) freshwater marsh, 2) floating marsh, 3) brackish-freshwater marsh, and 4) saline-brackish marsh. The freshwater marsh (peaty deposits) and floating marsh (marly organic) zones are characterized by freshwater with no brackish or saline water being normally present. The brackish-freshwater marsh forms highly-organic peaty zones, of which 10-20 percent is inorganic. This zone in Mississippi ranges from 1/2 mile to 8 miles wide (Ref: Kolb and Van Lopik, 1965). The degree of salinity concentration within this latter zone varies proportionately to the volume of freshwater influx from surface and subsurface sources. The maps and Figures 37 and 38 illustrate the four coastal environments, and depict areas needing detailed examination and/or identification.

Marine coastal environments consist of sandy sediments deposited in open-shelf, high energy Gulf Coast locales, while the silty, organic sandy deposits are laid down in low energy Bay/Sound environments. The latter environment, as a result of marine geochemical fluctuation, shallow water, and tidal effects provides an ideal environment for marine life.

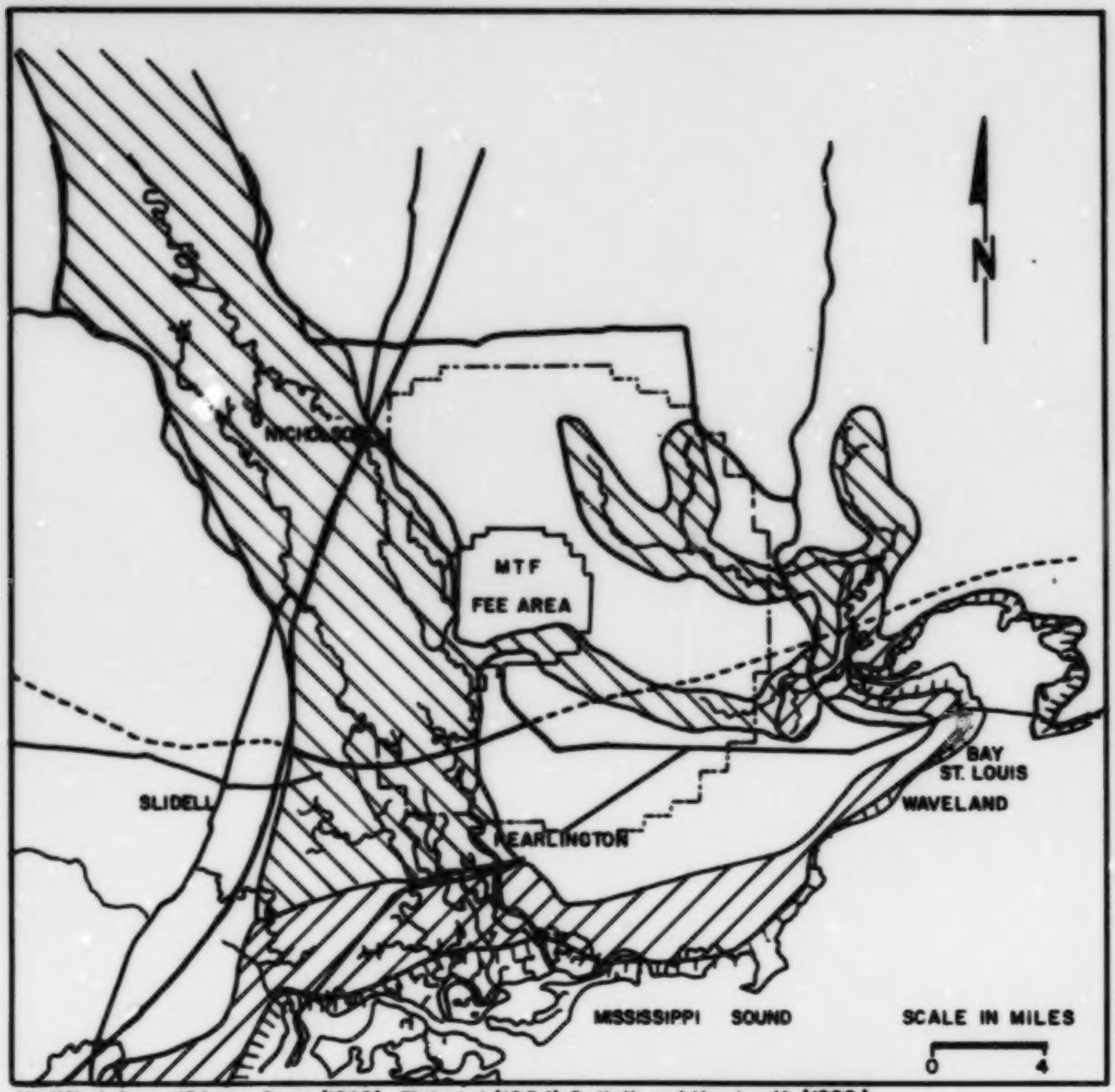
This well-protected environment (Mississippi Sound) is, however, subjected to wastes brought in by the water of the Pearl, Jourdan and Bayou La Croix drainage basins. Thus such impacts may disturb aspects of the local ecosystem, provided constant surveillance



Modified from USArmy Corps (1962), Fisk, et al (1954) & Kolb and Von Lopik (1966)

SCHEMATIC MAP VIEW OF COASTAL ENVIRONMENTS IN THE VICINITY OF THE MTF

Figure 37



Modified from USArmy Corps (1962), Fisk et al (1954) & Kolb and Von Lopik (1966)

▧ FRESH WATER

▨ FRESH / BRACKISH WATER

▤ BRACKISH / SALINE WATER

APPROXIMATE SURFACE SALINE / BRACKISH / FRESH WATER INTERFACE OBSERVED IN SOUTHWEST MISSISSIPPI

Figure 38

is not maintained. It is suggested that marine, paludal, fluvial-marine, and fluvial environments should be modeled and monitored to ensure that water quality standards are maintained and that fauna and flora are not affected by hazardous materials.

The influx of sediments into these environments can significantly alter one or all of these coastal environments (e.g., eutrophication). The degree of alterations is dependent on the types and chemical makeup of transported material, whether in solution or suspended. A detailed fluvial study should include a complete inventory of each coastal environment, directly (or indirectly) influenced by the drainage of the MTF site. The complete definition of each zone would enable or complete monitoring of future HMSE tests, as well as the effects of future MTF activities on aquatic and terrestrial biota in these coastal areas of the Mississippi Sound.

### Existing Mississippi Surface Water Quality

The characteristics of the MTF water quality were defined by testing for a few major ions, but it appears that many parameters, including heavy metals, were not tested. In order to define the baseline characteristics of the MTF, it is essential that a detailed monitoring program be conducted. If this phase of the baseline study is overlooked, the future evaluation of the impact on the environment of the proposed HMSE Facility would be impossible.

Surface water quality data (for the staging location on the Pearl River near the town of Columbia, Mississippi) were obtained from the 1969-1970 *Mississippi Water Resources Bulletin*. The data presented in Table 8 show among other parameters Ca, Mg, Na, conductance, color, turbidity, BOD, COD, coliform and temperature.

Another area where geochemical data are lacking is in definition of the saline/freshwater interface. This definition of the physical boundary between freshwater and saline water has been made by previous researchers; however, the chemical data have not been published. Table 9 includes data which describes the sediment deposits in the Mississippi Sound.

## CLIMATIC AND METEOROLOGICAL ASPECTS OF SOUTHWESTERN MISSISSIPPI AND THE MTF AREA

In southern Mississippi, the MTF site meteorological phenomena have been studied in depth in order to monitor both acoustical and climatological effects during the static firing of the Saturn V rocket. Detailed statistical analyses of temperature, humidity, and wind factors have been made by NASA and associated government agencies such as the Atmospheric Dynamics Branch of George C. Marshall Space Flight Center, Huntsville, Alabama.

TABLE 8 WATER QUALITY OF THE PEARL RIVER NEAR COLUMBIA, MISSISSIPPI DURING THE WATER YEAR NOVEMBER 1969 TO SEPTEMBER 1970 (Drainage Area--5,690 Sq. Miles)[1]

| Parameter | Date | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 11/6 | 12/17 | 2/5 | 3/19 | 4/29 | 6/10 | 7/29 | 9/9 |
| Discharge (cfs)[2] | 810 | 1520 | 5000 | 5150 | 8170 | 2500 | 900 | 975 |
| Calcium (Ca) (mg/1) | 12.0 | 15.0 | 11.0 | 12.0 | 10.0 | 13.0 | 5.0 | 7.0 |
| Magnesium (Mg) (mg/1) | 3.0 | 5.0 | 4.0 | 7.0 | -- | 6.0 | 3.0 | 5.0 |
| Sodium (Na) (mg/1) | 25.0 | 22.0 | -- | 14.0 | -- | 18.0 | 18.0 | 16.0 |
| Potassium (K) (mg/1) | 1.6 | 2.1 | -- | 1.7 | -- | 2.1 | 1.7 | 1.4 |
| Alkalinity as $CaCO_3$ (mg/1) | 24.0 | 40.0 | -- | 12.0 | 7.0 | 24.0 | 21.0 | 9.0 |
| Sulfate (SO4) (mg/1) | 14.0 | 14.0 | 15.0 | 14.0 | 0.7 | 5.9 | 15.0 | 9.1 |
| Phosphate ($PO_4$) (mg/1) | 0.22 | 0.41 | 0.12 | 0.15 | 0.05 | -- | 0.34 | 0.19 |
| Hardness (Ca, Mg) (mg/1) | 15.0 | 20.0 | 15.0 | 19.0 | 16.0 | 19.0 | 8.0 | 12.0 |
| Sodium Adsorption Ratio | 1.7 | 1.3 | -- | 0.8 | -- | 1.0 | 1.6 | 1.1 |
| Specific Conductance (Micromhos) | 90.0 | 88.0 | 58.0 | 70.0 | 43.0 | 89.0 | 100.0 | 68.0 |
| pH Units | 7.2 | 6.5 | 6.6 | 6.6 | 6.1 | 6.8 | 6.3 | 6.3 |
| Color (Platinum-Cobalt Units) | 30.0 | 45.0 | 30.0 | 45.0 | 35.0 | 35.0 | 45.0 | 30.0 |
| Turbidity (mg/1) | 25.0 | 25.0 | 120.0 | 27.0 | 38.0 | 20.0 | 10.0 | 10.0 |
| BOD (mg/1) | 1.2 | 2.3 | -- | 1.7 | -- | 0.3 | 0.3 | 0.9 |
| COD (mg/1) | 10.0 | 12.0 | 22.0 | 16.0 | 17.0 | 13.0 | 8.1 | 8.2 |
| Organic Nitrogen (N) (mg/1) | 0.62 | 1.0 | 1.5 | 0.7 | -- | 0.8 | 0.6 | 1.1 |
| Temperature (° C.) | 15.0 | 11.0 | 8.0 | 16.0 | 24.0 | 25.0 | 29.0 | 29.0 |
| DO (mg/1) | 8.7 | 9.5 | 10.7 | -- | 7.1 | 5.5 | 5.8 | 7.2 |
| Nitrite (N) (mg/1) | 0.32 | 0.38 | 0.19 | 0.2 | 0.1 | 0.1 | 0.5 | 0.6 |
| Coliform (Colonies per 100 ml.) | 8850 | 2350 | 2000 | 1100 | 1600 | 1100 | 3400 | 100 |

---

[1] Source: Water Resources Data for Mississippi, U.S. Department of the Interior, 1970.

[2] cfs, cubic ft/sec.; mg/1, milligrams/liter; $CaCO_3$, calcium carbonate; BOD, Biochemical Oxygen Demand; COD, Chemical Oxygen Demand; and DO, dissolved oxygen.

## TABLE 9 MISSISSIPPI SOUND SEDIMENT GEOCHEMICAL DATA[1]

| Location | $Fe^{+3}$[2] | $Al^{+3}$[3] | $NO_3$-N[4] | Total N[5] | Amino[6] | Salinity[7] | % Loss Ignition | Dry Density | Kind of Sediment |
|---|---|---|---|---|---|---|---|---|---|
| Mouth of Pearl River | | | | | | | | | Clay |
| 1/2-Mile Offshore, from Claiborne, Miss. | | | | | | | | | Silty Clay |
| 1/2-Mile Offshore from Waveland | | | .0011% | .03% | | | | 1.74 | Sandy Silt |
| Bay St. Louis Yacht Club | | | | .014% | .010% | 21.38 | | 2.48 | Silty Sand |
| 1-1/2 Mile SE Offshore from Pass Christian | | | .014% | .047% | | | 4.25 | 1.73 | Silty Clay |
| Biloxi Bay - near Marsh Point (Biloxi Bay - Back Bay) | .54% | 17.29% | .004% | .021% | .009% | 19.05 | .98 | 2.75 | Silty Sand |
| Davis Bayou near Shack Island | .16% | 2.62% | .013% | .069% | .066%<br>.015% | 25.16<br>25.14 | 8.32 | 2.49 | Silty Clay Mud |
| 1/2-Mile SE of Three Oaks Bayou (St. Joe Point) | 3.05% | 54.32% | .005% | .019% | .016% | 11.18 | 3.45 | 2.74 | Silty Clay |

---

[1] Priddy, *et al.*, 1955.
[2] Iron (Ferric)
[3] Aluminum
[4] Per cent Nitrogen found in Nitrate
[5] Total Nitrogen = ammonia -organic nitrogen, nitrate, nitrite nitrogen
[6] Amino = ammonium plus amino nitrogen
[7] Units in parts per thousand (ppt)

As a result of the extensive survey performed during the preparation of this report, it has been determined that additional data will be required to describe the micro-climatology of the MTF site. Data provided by Camp (1969) has, however, provided adequate regional and local climatic trends. These trends, incorporated in future studies, would require detailed monitoring of pollutants in relation to rainfall and to areas in the downwind direction.

## Southern Mississippi Climatic Air Mass Characteristics

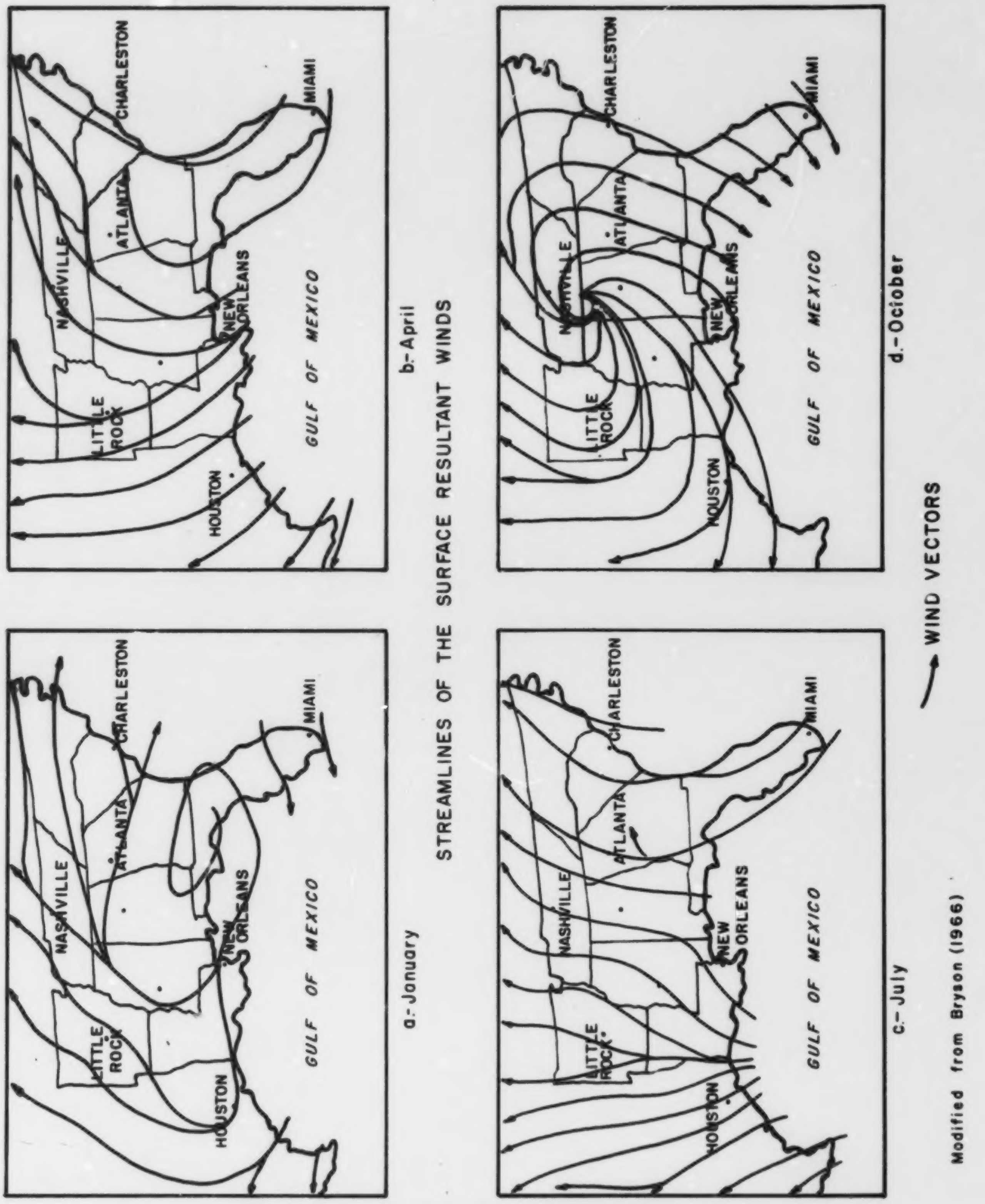
The interaction between thermal dynamics and physical factors may have a pronounced impact in the immediate area of the MTF. The present trends and defined climatic data reveal that the regional Mississippi climatic Koppen classification is Cfa (Ref: Trewartha, 1954). The Cfa represents a climatic zone of the humid-mesothermal-subtropical type, with summer temperatures greater than 71.6°F. The Southwest Mississippi Cfa climatic zone is subject to an unstable, subtropical high, which blows in from the west during the winter. Associated with these winter storm tracks are moist air masses which bring in low, drizzle-producing stratus clouds. Figure 39a illustrates the weak January storm track and its east-west lateral extent, as well as its more northerly influences. The influence of this Gulf mass starts to wane and head north-easterly on a line parallel to the Canadian-American border (St. Lawrence River).

The summer Gulf air masses, originating in the Caribbean, are warm, moist air masses, which, when pulled inland, bring torrential rains. Figure 39b illustrates the gradual storm track change in intensity from winter through the spring into the summer months. The gradual changes in intensity are best illustrated in Figure 39c (Ref: Bryson, 1966).

## Rainfall and Temperature Characteristics

The regional Southwest Mississippi climatic data (Ref: National Weather Service, 1972), shows an average monthly rainfall of 2.6 to 7.0 in., with a total yearly average of 58.13 in. There is an average of 154 cloudless days and 117-130 partly-cloudy days. Associated with the rainfall are high humidities ranging from 75 percent to 84 percent.

The prevailing regional winds originate from the north from August to February, and from the south-southeast from March to July. The velocities normally associated with these prevailing winds range from 8 to 10 mph. Regional temperatures range from 56°F. to 100°F., while winter temperatures rarely drop below freezing (however, a low of 2°F. has been recorded). The regional climatic summary shows that the area has:



STREAMLINES OF THE SURFACE RESULTANT WINDS

Modified from Bryson (1966)

## REGIONAL CLIMATIC SYSTEM
## SOUTHEASTERN UNITED STATES

Figure 39

1) A long growing season (about 270 frost-free days).
2) Evenly distributed precipitation throughout the year (average 4.9 in. monthly).
3) Low wind velocities (8 to 10 mph).
4) High relative humidities, with little annual variation (ranging from about 80 percent in January to about 78 percent in July).
5) A high degree of solar insolation, partially screened by high relative humidities (about 210 Langleys in January and about 420 Langleys in July).
4) About 50 percent possible sunshine in January, and about 60 percent in July.
5) Mean annual total snowfall less than 1 in.
6) Date for first frost about December 15, for last frost about February 15.
7) Mean annual number of days with temperatures greater than 90°F. averages 60 days.
8) Mean annual number of days with temperatures less than 32°F. averages 5 to 10 days.

## Local Meteorology -- Southwestern Mississippi

Local climatological data for Hancock and Harrison Counties in southwestern Mississippi have been provided by the 30-year-old weather station located at Bay St. Louis, Mississippi. Additional local climatology has been furnished by NASA-ESSA MTF, which has been operating since 1963. Table 10 gives a 30-year summary (Bay St. Louis), indicating that the driest month is October (average 2.4 in. precipitation) while the wettest month is June (average 6.8 in. precipitation). The least amount of precipitation recorded for a month was a trace, while the greatest amount recorded for a single month was 20.2 in. for June, 1900. The station recorded a mean maximum temperature of 97°F. during August (as illustrated in Table 11), and a mean minimum temperature of 24°F. during January. The highest temperature recorded was 104°F. in July, 1924, and the lowest temperature recorded was 2°F. in February, 1889 (Ref: National Climatic Center, 1972).

The MTF local temperatures recorded for the last nine years averaged 65.6°F., with an average minimum of 17.4°F. and an average maximum of 97.4°F. The ESSA weather station (Bldg. 8201) on the site recorded an average annual precipitation of 56.06 in., and an average annual maximum wind velocity of 58 knots (66.7 mph), with a generally south-southeast prevailing wind. The MTF has also recorded an average maximum daily precipitation of 4.69 in., and an average monthly maximum of 9.44 in.

TABLE 10 SUMMARY OF MONTHLY (1892-1970) PRECIPITATION DATA, HANCOCK COUNTY, MISSISSIPPI[1]
(National Weather Service, Jackson, Mississippi)

| | | Extremes | | | | | | Mean # of Days/Mo. | |
|---|---|---|---|---|---|---|---|---|---|
| Month | Mean Total[2] | Max. Amt.[2] | Year | Min. Amt.[2] | Year | 1-Day Greatest Amt.[2] | 1-Day Year | 0.10" or More | 0.50" or More |
| Jan. | 5.0 | 14.3 | 1892 | 0.68 | 1927 | 6.3 | 1965 | 6 | 3 |
| Feb. | 4.5 | 11.0 | 1928 | 0.75 | 1892 | 5.8 | 1927 | 6 | 3 |
| March | 5.9 | 14.8 | 1948 | 0.10 | 1955 | 6.5 | 1922 | 5 | 3 |
| April | 5.2 | 16.2 | 1912 | 0.01 | 1915 | 10.9 | 1964 | 5 | 3 |
| May | 3.9 | 17.8 | 1932 | 0.04 | 1899 | 10.1 | 1932 | 4 | 2 |
| June | 4.6 | 20.2 | 1900 | 0.28 | 1907 | 9.5 | 1900 | 5 | 2 |
| July | 6.8 | 18.0 | 1941 | 0.46 | 1947 | 8.0 | 1931 | 8 | 4 |
| Aug. | 6.1 | 16.4 | 1926 | 0.19 | 1954 | 6.7 | 1931 | 7 | 4 |
| Sept. | 6.6 | 19.9 | 1957 | 0.10 | 1933 | 10.3 | 1957 | 6 | 3 |
| Oct. | 2.4 | 15.0 | 1918 | 0.00 | 1953 | 5.9 | 1937 | 3 | 1 |
| Nov. | 3.6 | 11.9 | 1948 | T | 1949 | 8.4 | 1961 | 4 | 2 |
| Dec. | 5.2 | 11.6 | 1931 | 1.13 | 1959 | 5.2 | 1907 | 6 | 3 |
| Ann. | 59.8 | 101.5 | 1900 | 28.66 | 1962 | 10.9 | 1964 | 65 | 33 |
| # of Yrs. for record | 30 | 74-79 | | 74-79 | | 74-79 | | 17-20 | 17-20 |

---

[1] All data from the Bay St. Louis Station, Hancock Co., Mississippi (through 1970).

[2] Expressed in inches; T, Trace or an amount too small to measure.

TABLE 11 SUMMARY OF MONTHLY (1899-1970) TEMPERATURE DATA, HANCOCK COUNTY, MISSISSIPPI[1]
(National Weather Service, Jackson, Mississippi)

| | Means | | | | | Extremes | | | | Mean # of Days | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Daily Max.[2] | Daily Min. | Mthly. | Mthly. High Max. | Mthly. Low Min. | High | Year | Low | Year | Max. 90° F & above | Min. 32° F & below |
| Jan. | 60 | 42 | 51 | 73 | 24 | 82 | 1911 | 10 | 1963+ | --- | 6 |
| Feb. | 63 | 45 | 54 | 75 | 29 | 83 | 1923 | 2 | 1899 | --- | 3 |
| March | 68 | 50 | 59 | 80 | 33 | 92 | 1946 | 21 | 1932 | * | 1 |
| April | 76 | 60 | 68 | 86 | 45 | 92 | 1946+ | 32 | 1915 | * | --- |
| May | 84 | 67 | 75 | 91 | 53 | 97 | 1953 | 41 | 1929+ | 3 | --- |
| June | 89 | 73 | 81 | 95 | 65 | 102 | 1901 | 53 | 1907 | 14 | --- |
| July | 90 | 74 | 82 | 96 | 65 | 104 | 1932 | 62 | 1924+ | 18 | --- |
| Aug. | 90 | 74 | 82 | 97 | 68 | 103 | 1947 | 60 | 1931 | 19 | --- |
| Sept. | 86 | 70 | 78 | 93 | 59 | 103 | 1927 | 45 | 1967 | 8 | --- |
| Oct. | 79 | 59 | 69 | 88 | 43 | 97 | 1904 | 33 | 1898 | 1 | --- |
| Nov. | 69 | 49 | 59 | 78 | 32 | 90 | 1938 | 21 | 1940+ | --- | 1 |
| Dec. | 62 | 44 | 53 | 75 | 28 | 81 | 1922+ | 12 | 1962 | --- | 4 |
| Ann. | 76 | 59 | 68 | 98[3] | 23[4] | 104 | 1932 | 2 | 1899 | 63 | 15 |
| # of Yrs. Recorded | 28-30 | 28-30 | 30 | 28-30 | 28-30 | 72-77 | | 71-77 | | 28-30 | 27-30 |

---

[1] All data from the Bay St. Louis Station, Hancock County, Mississippi (through 1970).
[2] All values expressed in ° F.
[3] Mean annual highest maximum.
[4] Mean annual lowest minimum.
*Less than 1/2 day.
+Also occurred in earlier years.

## Micrometeorologic Wind and Temperature Survey of the MTF

Wind and temperature statistics for the MTF area, inversion frequency and dispersion rates have been studied in detail by Dennis W. Camp and John W. Kaufman (1969), who were associated with Atmospheric Dynamics Branch, Aerospace Environment Division, Area Astrodynamic Laboratory, NASA--Marshall Space Flight Center, Huntsville, Alabama. Their study involved detailed climatological data for a 2-year period, with emphasis on air stability and air circulation.

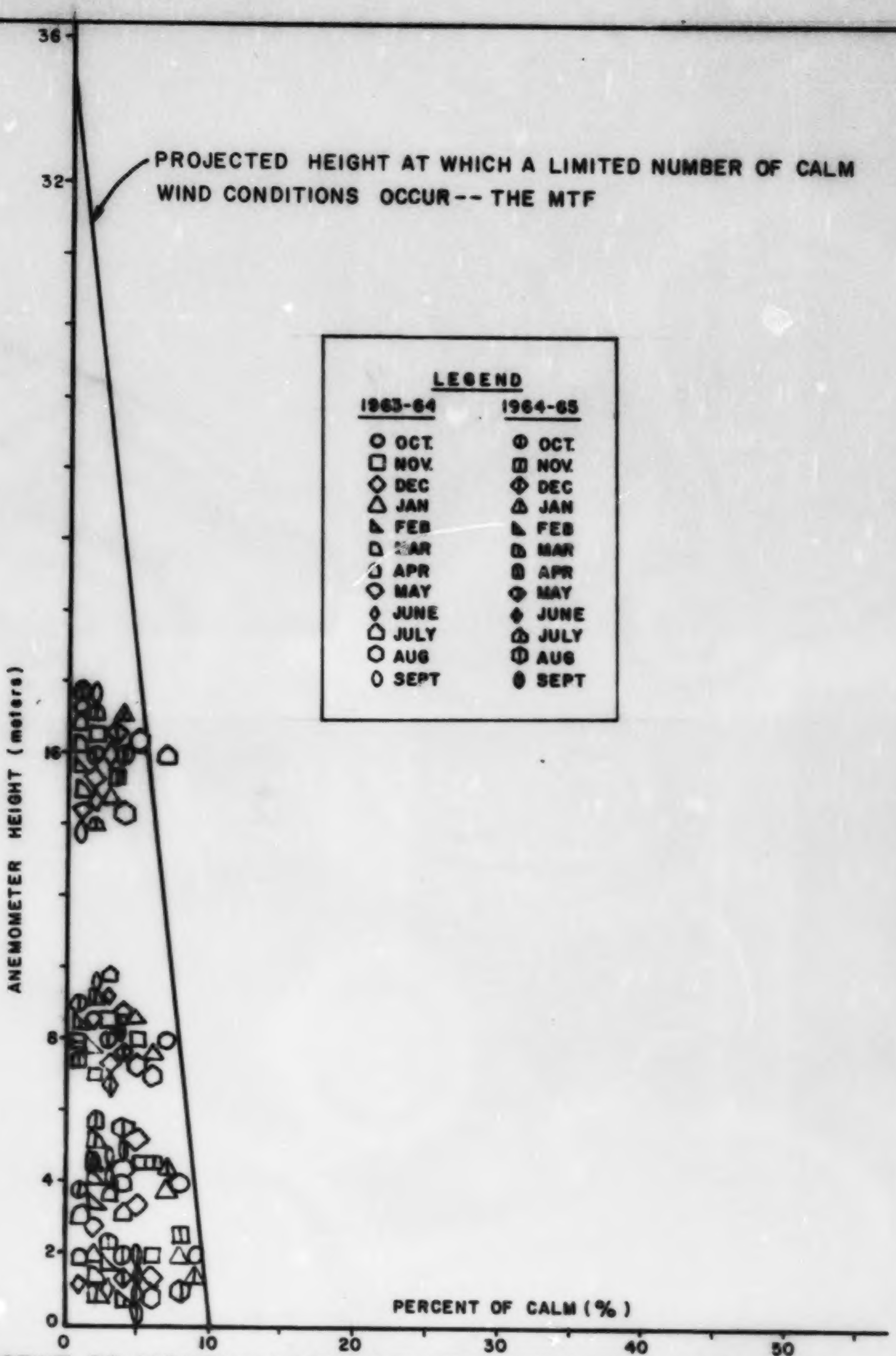
The air stability experiments recorded vertical air temperature variations, as well as wind velocity and direction, in order to determine the interrelationship between upper and lower air circulation. The study defined the height, time, and day (i.e., where and when) air inversions were monitored. This monitoring enabled understanding, as well as a quantitative method of measuring the rate of dispersion, of various local atmospheric stratigraphic columns.

Presented in their report are maximum-minimum and average air temperatures for the MTF, as well as the percent of calm wind conditions, on a monthly and yearly basis. Anemometer readings were recorded at 2-, 4-, 8-, and 16- meters, with constant temperature readouts every 2.5 minutes.

Figures 40 and 41 represent, respectively, the percent of monthly daytime and nighttime periods of calm wind conditions that occur at 2-, 4-, 8-, 16-, and a projected 36-meter height. These charts indicate the percent of air circulation during the day to be greater than that at night, and give the approximate percent of time at which air remains relatively stagnant. Figure 42 shows a two-year monthly summary of relative percent of calm air. It can be observed that the month of August has the minimum values for air circulation at 2-,4-, and 16- meters. The maximum values for air circulation at 16-meters occur during February and March.

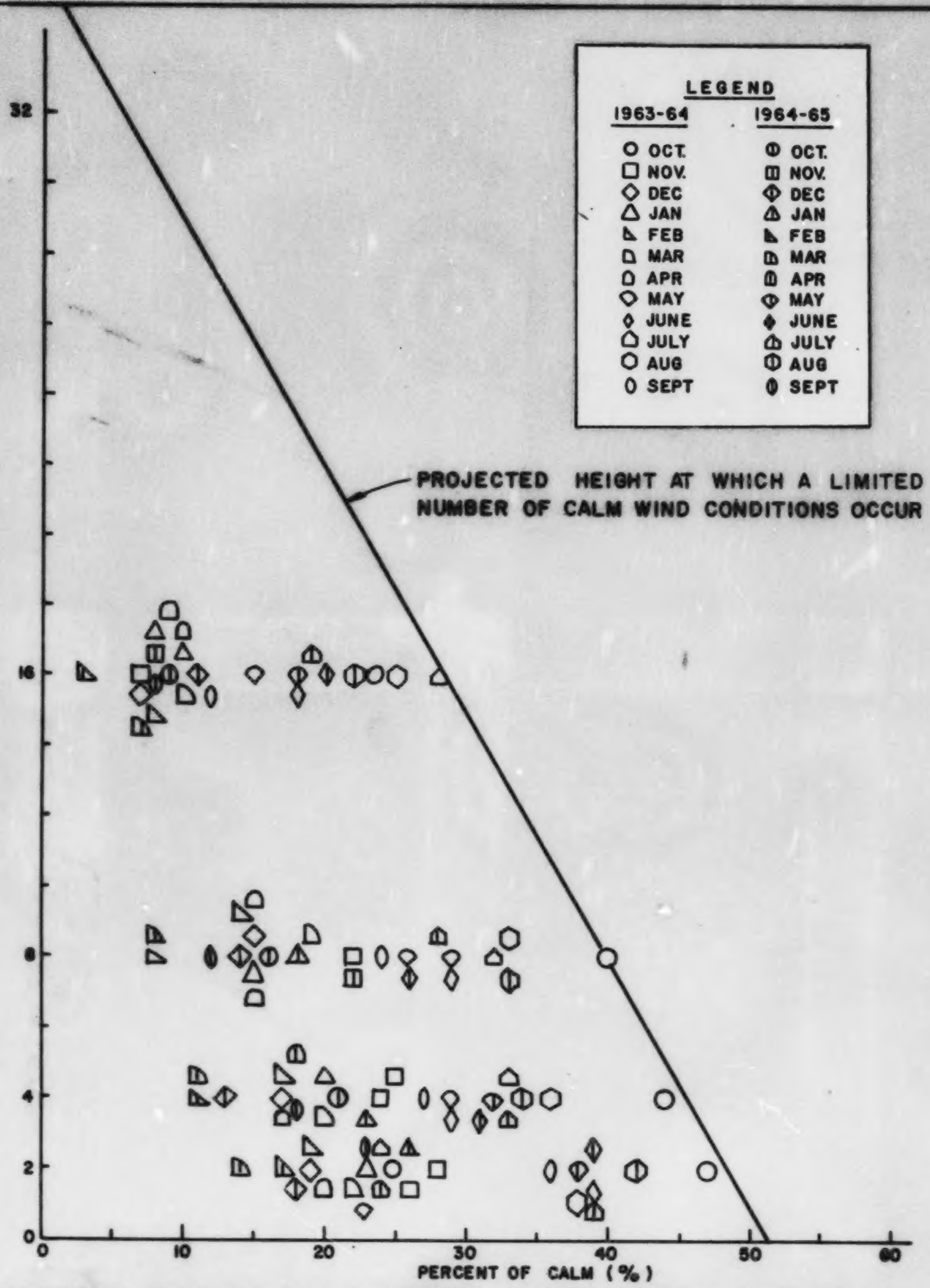
The air temperature charts in Figure 43 illustrate, at least during the 2-year monitoring period, that possible well-defined air inversions may have occurred during the months of July to September (provided upper air is warmer than surface temperatures). These atmospheric stratifications may have occurred between 2100-0800 hours Central Standard Time (CST), with the inversions breaking up between 0900-2000 hours Central Standard Time (CST). Inversion frequency for the two years during the study could not be extrapolated from the reviewed literature.

A summary of the yearly wind profile observed at the MTF weather station in 1964, for anemometer levels 2-, 4-, 8-, and 16 meters, are respectively illustrated (in percent of probability) in Tables 12 through 15. Wind rosettes (Figures 44 and 45) give indications of the duration and the average wind velocity recorded.



PERCENT OF MONTHLY DAYTIME PERIODS (0700-1800) CALM WIND CONDITIONS OCCUR AT INDICATED HEIGHTS **Figure 40**

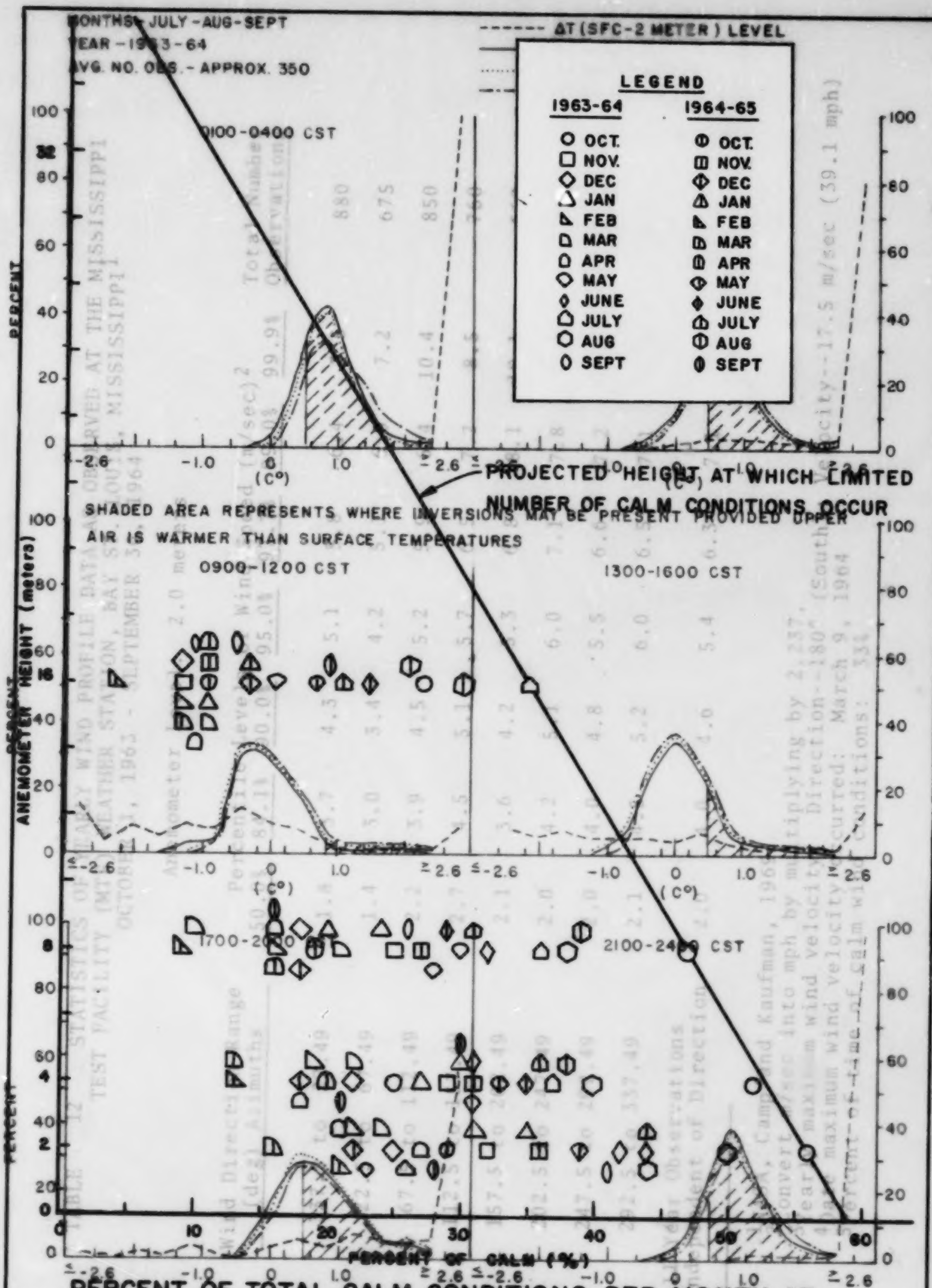
From CAMP & KAUFMAN (1969)



PERCENT OF MONTHLY NIGHTTIME PERIODS (1900-0600 CST) CALM WIND CONDITIONS OCCUR AT INDICATED HEIGHTS

Figure 41

Modified from CAMP & KAUFMAN (1969)



**PERCENT OF TOTAL CALM CONDITIONS PER MONTH AT INDICATED HEIGHTS -- THE MTF**

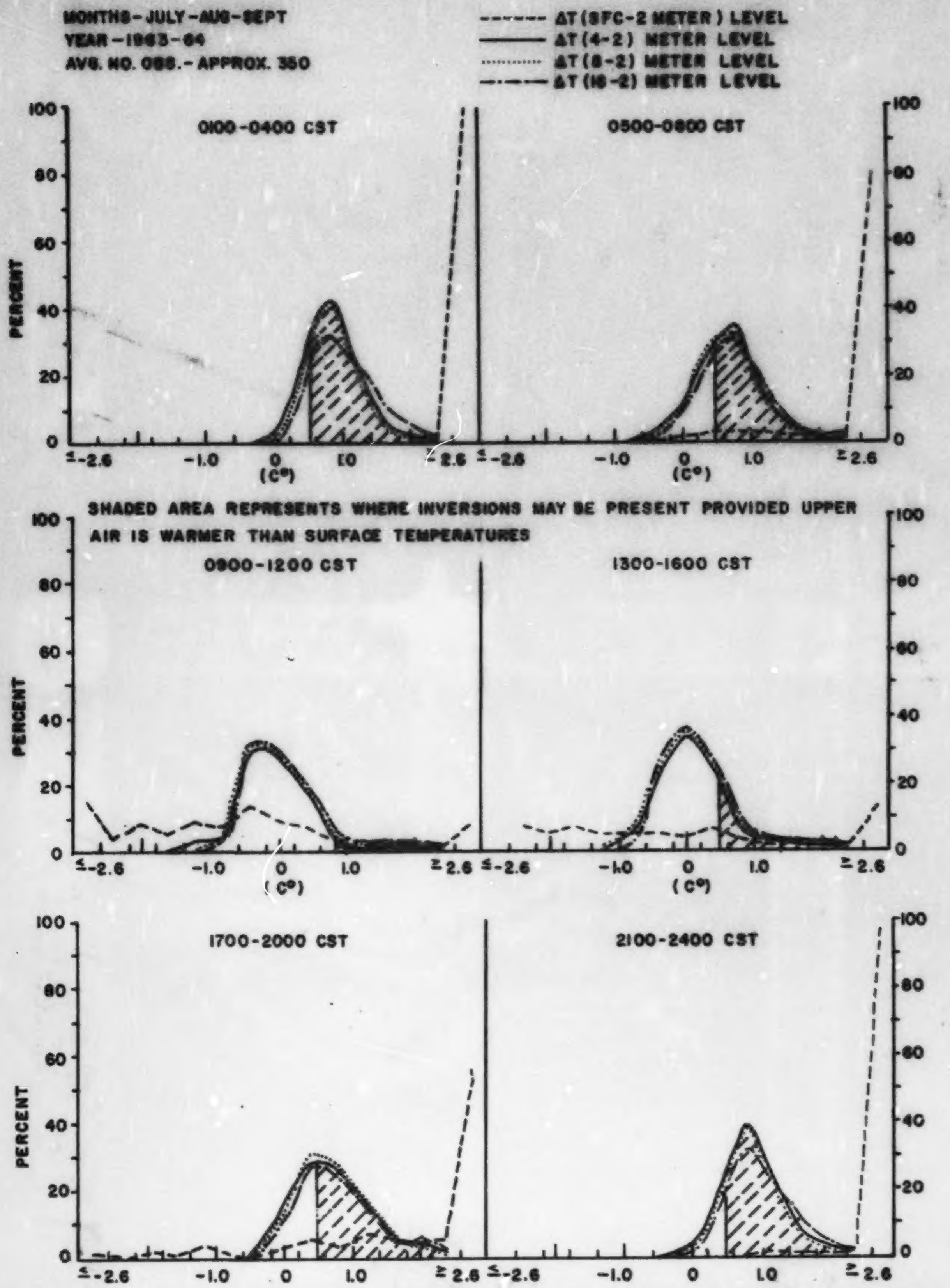
**Figure 42**

**Modified from CAMP & KAUFMAN (1969)**

PERCENT O [illegible] OCCUR FOR 0.48 C RANGES AS OBTAINED FROM THE MTF TEMPERATURE PROFIL DATA

Figure 43

Modified from CAMP & KAUFMAN (1969)



PERCENT OF TIME TEMPERATURE DIFFERENCES (ΔT) OCCUR FOR 0.40°C RANGES AS OBTAINED FROM THE MTF TEMPERATURE PROFILE DATA

Modified from CAMP & KAUFMAN (1969)

Figure 43

TABLE 12 STATISTICS OF YEARLY WIND PROFILE DATA AS OBSERVED AT THE MISSISSIPPI TEST FACILITY (MTF) WEATHER STATION, BAY ST. LOUIS, MISSISSIPPI[1]
OCTOBER 1, 1963 - SEPTEMBER 30, 1964

Anemometer Level: 2.0 meters

| Wind Direction Range (deg) Azimuths | Percentile Levels of Wind Speed (m/sec)[2] | | | | | | | Total Number Observations |
|---|---|---|---|---|---|---|---|---|
| | 50.0% | 84.1% | 90.0% | 95.0% | 97.7% | 99.0% | 99.9% | |
| 337.5 to 22.49 | 1.8 | 3.7 | 4.3 | 5.1 | 5.8 | 6.4 | 7.5 | 880 |
| 22.5 to 67.49 | 1.4 | 3.0 | 3.4 | 4.2 | 5.1 | 6.0 | 7.2 | 675 |
| 67.5 to 112.49 | 2.2 | 3.9 | 4.5 | 5.2 | 5.9 | 6.4 | 10.4 | 850 |
| 112.5 to 157.49 | 2.7 | 4.5 | 5.1 | 5.7 | 6.5 | 7.2 | 8.5 | 760 |
| 157.5 to 202.49 | 2.1 | 3.6 | 4.2 | 5.3 | 6.8 | 8.1 | 10.1 | 562 |
| 202.5 to 247.49 | 2.0 | 4.2 | 5.1 | 6.0 | 7.1 | 7.8 | 8.4 | 339 |
| 247.5 to 292.49 | 2.0 | 4.0 | 4.8 | 5.5 | 6.6 | 7.2 | 8.2 | 457 |
| 292.5 to 337.49 | 2.1 | 4.5 | 5.2 | 6.0 | 6.5 | 7.1 | 7.9 | 830 |
| All Year Observations Independent of Direction | 2.0 | 4.0 | 4.6 | 5.4 | 6.3 | 7.1 | 8.4 | 5353 |

---

[1] NASA, Camp and Kaufman, 1969.
[2] Convert m/sec into mph by multiplying by 2.237.
[3] Yearly maximum wind velocity: Direction--180° (South); Velocity--17.5 m/sec (39.1 mph)
[4] Date maximum wind velocity occurred: March 9, 1964
[5] Percent of time of calm wind conditions: 33%

## TABLE 13 STATISTICS OF YEARLY WIND PROFILE DATA AS OBSERVED AT THE MISSISSIPPI TEST FACILITY (MTF) WEATHER STATION, BAY ST. LOUIS, MISSISSIPPI[1] OCTOBER 1, 1963 - SEPTEMBER 30, 1964

Anemometer Level: 4.0 meters

| Wind Direction Range (deg) Azimuths | Percentile Levels of Wind Speed (m/sec)[2] | | | | | | | Total Number Observations |
|---|---|---|---|---|---|---|---|---|
| | 50.0% | 84.1% | 90.0% | 95.0% | 97.7% | 99.0% | 99.9% | |
| 337.5 to 22.49 | 2.0 | 4.4 | 5.0 | 5.8 | 6.5 | 7.4 | 10.4 | 964 |
| 22.5 to 67.49 | 1.4 | 2.9 | 3.4 | 4.2 | 5.1 | 5.7 | 7.5 | 800 |
| 67.5 to 112.49 | 2.3 | 4.0 | 4.5 | 5.1 | 5.7 | 6.4 | 8.1 | 929 |
| 112.5 to 157.49 | 2.7 | 4.6 | 5.2 | 5.7 | 6.4 | 7.1 | 8.4 | 852 |
| 157.5 to 202.49 | 2.0 | 3.6 | 4.2 | 5.1 | 6.3 | 7.5 | 8.6 | 698 |
| 202.5 to 247.49 | 1.8 | 3.7 | 4.4 | 5.4 | 6.4 | 7.7 | 8.4 | 417 |
| 247.5 to 292.49 | 1.9 | 4.0 | 4.6 | 5.8 | 6.6 | 7.2 | 8.8 | 499 |
| 292.5 to 337.49 | 2.2 | 4.7 | 5.2 | 5.8 | 6.4 | 7.2 | 8.5 | 927 |
| All Year Observations Independent of Direction | 2.1 | 4.1 | 4.7 | 5.4 | 6.3 | 7.1 | 8.5 | 6086 |

---

[1] NASA, Camp and Kaufman, 1969.

[2] Convert m/sec into mph by multiplying by 2.237.

[3] Yearly maximum wind velocity: Direction--135° (Southeast); Velocity--17 m/sec (38 mph)

[4] Date maximum wind velocity occurred: April 26, 1964

[5] Percent of time of calm wind conditions: 29.7%

## TABLE 14 STATISTICS OF YEARLY WIND PROFILE DATA AS OBSERVED AT THE MISSISSIPPI TEST FACILITY (MTF) WEATHER STATION, BAY ST. LOUIS, MISSISSIPPI[1]

OCTOBER 1, 1963 - SEPTEMBER 30, 1964

Anemometer Level: 8.0 meters

| Wind Direction Range (deg) Azimuths | Percentile Levels of Wind Speed (m/sec)[2] | | | | | | | Total Number Observations |
|---|---|---|---|---|---|---|---|---|
| | 50.0% | 84.1% | 90.0% | 95.0% | 97.7% | 99.0% | 99.9% | |
| 337.5 to 22.49 | 2.2 | 5.0 | 5.6 | 6.5 | 7.4 | 8.2 | 11.8 | 1011 |
| 22.5 to 67.49 | 1.5 | 3.2 | 3.8 | 4.7 | 5.4 | 6.4 | 7.4 | 780 |
| 67.5 to 112.49 | 2.5 | 4.6 | 5.1 | 5.5 | 6.3 | 7.0 | 10.3 | 915 |
| 112.5 to 157.49 | 3.0 | 5.2 | 5.6 | 6.5 | 7.4 | 8.2 | 9.5 | 896 |
| 157.5 to 202.49 | 2.1 | 4.3 | 4.9 | 5.6 | 6.5 | 8.1 | 12.5 | 739 |
| 202.5 to 247.49 | 1.9 | 4.4 | 5.1 | 5.9 | 7.2 | 8.1 | 9.9 | 441 |
| 247.5 to 292.49 | 2.0 | 4.6 | 5.3 | 6.4 | 7.6 | 8.2 | 9.2 | 517 |
| 292.5 to 337.49 | 2.5 | 5.5 | 6.2 | 7.1 | 8.0 | 8.6 | 11.8 | 972 |
| All Year Observations Independent of Direction | 2.2 | 4.7 | 5.3 | 6.3 | 7.2 | 8.1 | 10.5 | 6271 |

---

[1] NASA, Camp and Kaufman, 1969.

[2] Convert m/sec into mph by multiplying by 2.237.

[3] Yearly maximum wind velocity: Direction--180° (South); Velocity--19.6 m/sec (43.8 mph)

[4] Date maximum wind velocity occurred: March 9, 1964

[5] Percent of time of calm wind conditions: 27%

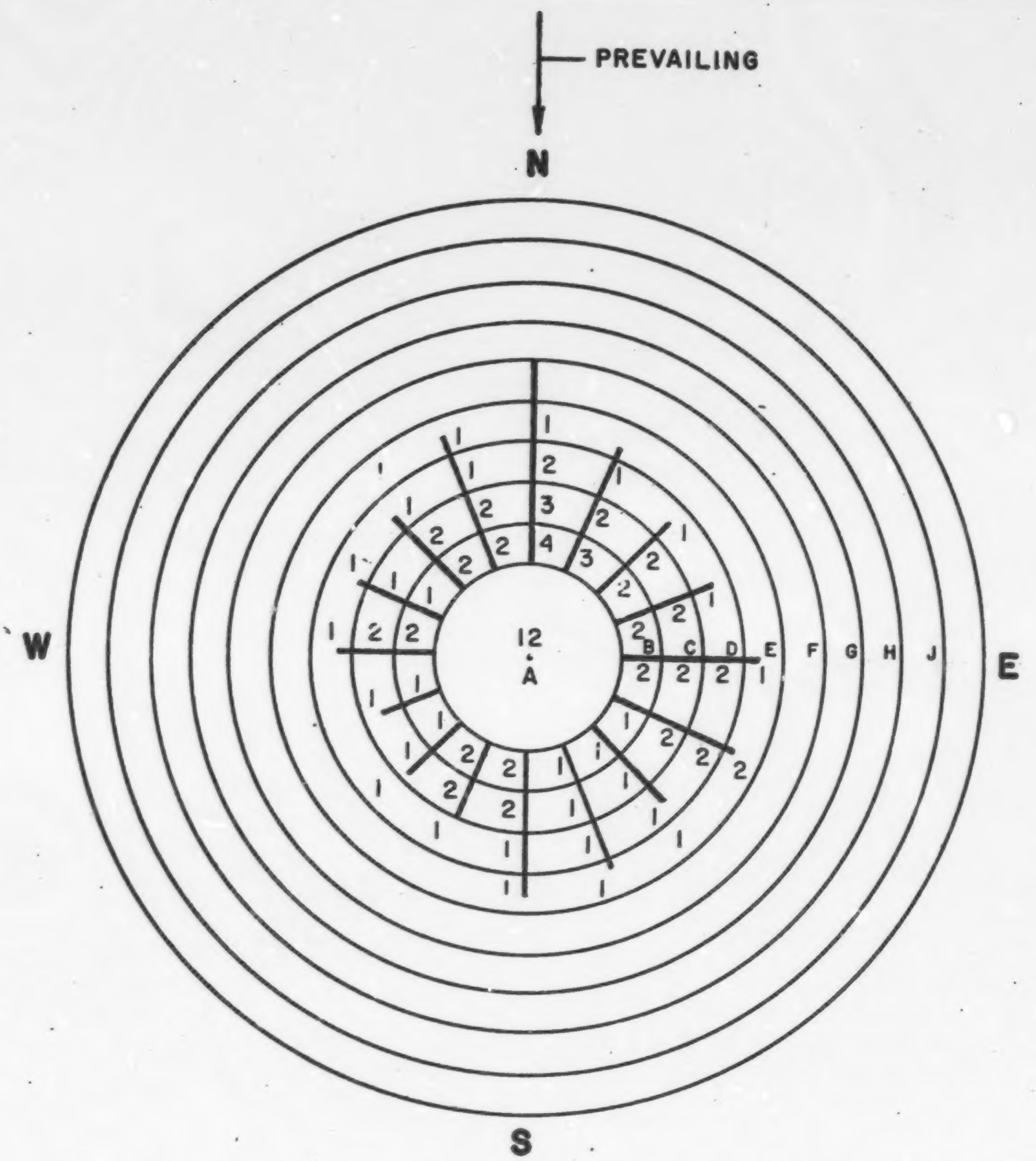
TABLE 15 STATISTICS OF YEARLY WIND PROFILE DATA AS OBSERVED AT THE MISSISSIPPI TEST FACILITY (MTF) WEATHER STATION, BAY ST. LOUIS, MISSISSIPPI[1]
OCTOBER 1, 1963 - SEPTEMBER 30, 1964

Anemometer Level: 16.0 meters

| Wind Direction Range (deg) Azimuths | Percentile Levels of Wind Speed (m/sec)[2] 50.0% | 84.1% | 90.0% | 95.0% | 97.7% | 99.0% | 99.9% | Total Number Observations |
|---|---|---|---|---|---|---|---|---|
| 337.5 to 22.49 | 1.5 | 3.6 | 4.5 | 5.3 | 6.2 | 6.8 | 7.8 | 1076 |
| 22.5 to 67.49 | 1.5 | 3.2 | 3.8 | 4.8 | 5.6 | 6.3 | 7.5 | 912 |
| 67.5 to 112.49 | 2.5 | 4.6 | 5.1 | 5.7 | 6.4 | 7.2 | 10.1 | 1033 |
| 112.5 to 157.49 | 2.5 | 5.0 | 5.5 | 6.3 | 7.3 | 8.1 | 9.4 | 903 |
| 157.5 to 202.49 | 1.8 | 3.9 | 4.7 | 5.5 | 7.0 | 7.8 | 9.5 | 773 |
| 202.5 to 247.49 | 1.6 | 3.8 | 4.9 | 6.0 | 7.2 | 8.1 | 10.1 | 567 |
| 247.5 to 292.49 | 2.0 | 4.7 | 5.5 | 6.6 | 7.5 | 8.5 | 10.0 | 700 |
| 292.5 to 337.49 | 2.2 | 5.1 | 5.8 | 6.7 | 7.4 | 8.1 | 10.0 | 1152 |
| All Year Observations Independent of Direction | 1.9 | 4.4 | 5.1 | 6.0 | 7.0 | 7.7 | 9.6 | 7116 |

---

[1] NASA, Camp and Kaufman, 1969.
[2] Convert m/sec into mph by multiplying by 2.237.
[3] Yearly maximum wind velocity: Direction--175° (South); Velocity--19.6 m/sec (43.8 mph)
[4] Date maximum wind velocity occurred: March 9, 1964
[5] Percent of time of calm wind conditions: 16.8%



## ANNUAL WIND ROSE

Line denotes percentage of occurrence of winds from direction indicated. Starting from 1st circle, each subsequent circle represents 2 percent.

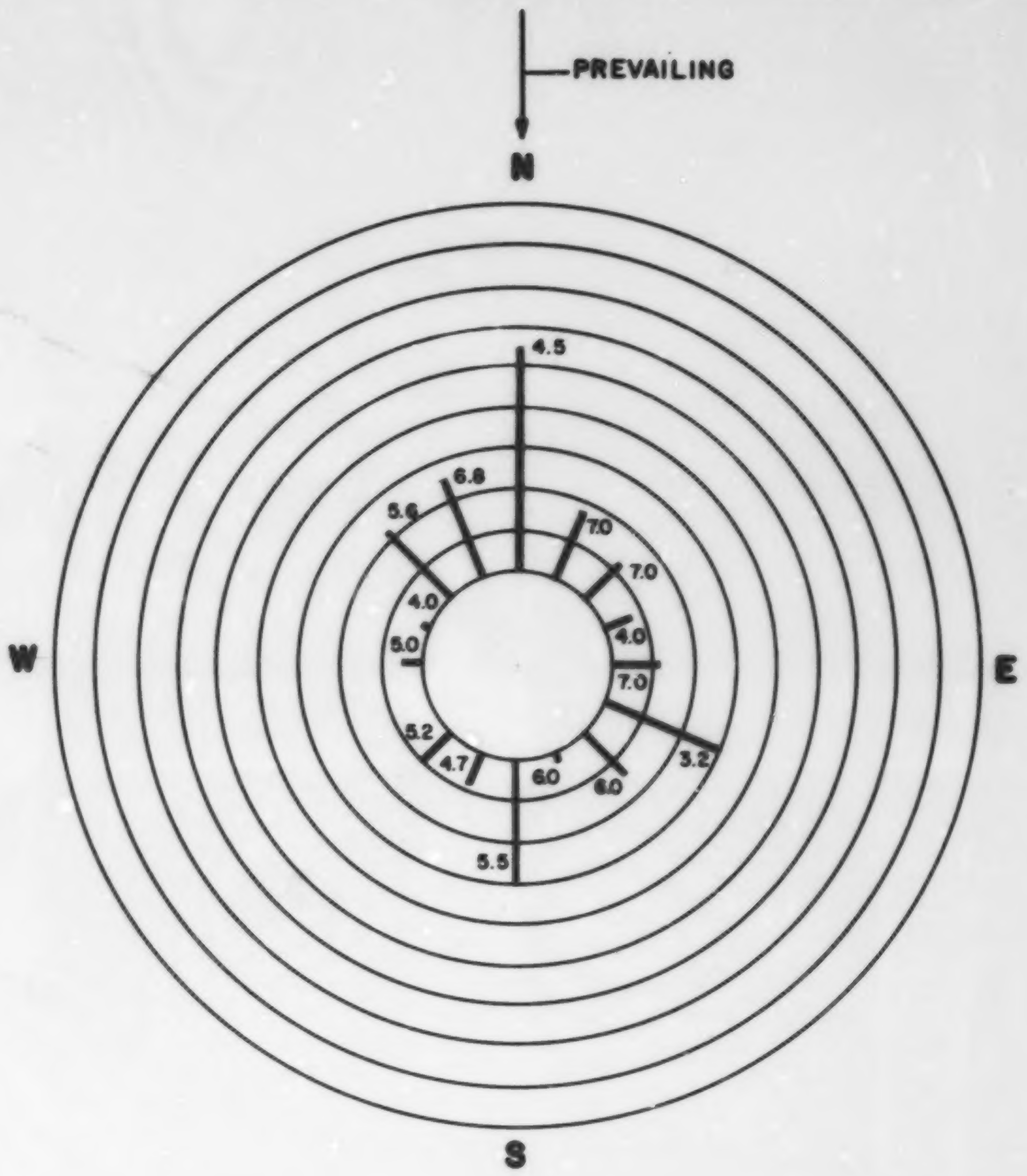
Numbers indicate percentage of occurrence of winds in each group category. "-" indicates percentage value of less than 0.5 percent.

Group Categories (kph)

A Calm
B -- 0-3
C -- 4-6
D -- 7-9
E -- 10-12
F -- 13-15
G -- 16-18
H -- 19-20
J -- 20+

Figure 44

From MTF MASTER PLAN 1971



THE MTF
AVERAGE ANNUAL WIND ROSE
1963—1971

Line denotes percentage of occurrence of winds from direction indicated. Starting from 1st circle, each subsequent circle represents 4 percent.

Numbers indicate average wind velocity in mph (miles per hour).

**Figure 45**

From NOAA (1972)

at the MTF. Figure 44 is an annual rosette (Ref: Master Plan, NASA, 1971) which represents the annual north-south prevailing winds, which make up 17.5 percent of total circulation in the MTF vicinity, while the east-west vector makes up approximately 11 percent. The wind rosette (Figure 45) represents the average maximum prevailing wind recorded for 9 years (1963-1971) at the MTF. The rosette illustrates the prevailing wind vector coming from the north (22 percent of the time) with an average velocity of 4.5 mph. The strongest average wind velocity recorded was blowing from the east-southeast at an average velocity of 8.2 mph (maximum 43.8 mph--March 9, 1964) for an average maximum of 12 percent of the year. Formulation of this rosette did not take into account periods of calm.

## Hurricane Conditions in the MTF Area

The probability of a hurricane in the low-lying, coastal deltaic regions of the Mississippi Sound is an annual threat. In the past, many hurricanes have left the Mississippi Coast devastated, but it is believed that the impact of Hurricane Camille was the worst storm that ever struck North America (at least in the last 143 years),Ref.: Gunter and Eleutarius (1971), and Chabreck and Palmisano (1973). During Hurricane Camille (August 17-18, 1969), winds were clocked at 218 mph. The unusual barometric pressure of 216.01 in., and the release of 11.76 in. of rain were recorded, Rhyne (1973). Hurricanes threatening or reaching the MTF since 1963 are recorded in the following summary:

| Hurricane | | Date |
|---|---|---|
| Cindy | Threat | Sept. 16-17, 1963 |
| Hilda | Actual | Oct. 3-4, 1964 |
| Betsy | Actual | Sept. 9-10, 1965 |
| Inez | Threat | Sept. 23 - Oct. 10, 1966 |
| Beulah | Threat | Sept. 16-20, 1967 |
| Fern | Threat | Oct. 2-4, 1967 |
| Gladys | Threat | Oct. 15-18, 1968 |
| Camille | Actual | Aug. 17-18, 1969 |
| Laurie | Threat | Oct. 19-21, 1969 |
| Becky | Threat | July 20-22, 1970 |
| Celia | Threat | August 1-3, 1970 |
| Ella | Threat | Sept. 10-12, 1970 |
| Felice | Threat | Sept. 13-16, 1970 |
| Edith | Actual | Sept. 8-16, 1971 |
| Fern | Threat | Sept. 8-10, 1971 |
| Laura | Threat | Nov. 15-19, 1971 |

(Ref: National Weather Service, 1972)

Figure 36 ia a coastal map of Hancock and Harrison Counties, Mississippi, and illustrates areas where Hurricane Camille tidal limits were recorded. The saline water was recorded to the southeast and southwest of the MTF Buffer Zone. This may be a significant factor in locating potential future testing sites of HMSE.

## Acoustical Studies of the MTF

The MTF acoustical characteristics have been defined in detail to describe sound attenuation throughout the Fee and Buffer Zones. Further experimentation will need to be initiated if explosive (incineration) techniques are utilized, if it is estimated that noise generated will be greater than the noise propagated by the S-II static firing. It is believed that explosive propagated noise less than S-II may be extrapolated from data submitted by Reisig (1965).

Acoustical/environmental studies for the MTF, with an actual demonstration of acoustical attenuation, utilized the actual firing of the Orbiter single engine. Information for the acoustical analysis of the MTF was derived from NASA Technical Memorandum X-53486 written by Gerhard H.R. Reisig (1965).

The synopsis of acoustical data are pertinent to defining sound focusing and sound attenuation with atmospheric definition, scattering affects, air viscosity, molecular absorption, heat conduction, air turbulence, temperature and wind gradients as the controlling factors. The MTF acoustical experimentation was performed, utilizing a point source to propagate noise. Analyses were made of propagated noise frequencies of 40, 80, 120 and 160 Hz (Hertz [Hz] units of frequency in cycles per second, which are measured along 8 azimuths [azimuths were 30°, 76°, 103°, 140°, 175°, 232°, 280° and 340°]). Experimentation indicated that an empirical maximum amplification (focusing) occurred at 22 kilometers which showed an abnormal 50 decibel(dB) level. Table 16 illustrates dB levels which affect man.

Figure 46a illustrates graphically the probability of sound focusing by azimuth at the MTF. The data suggest that the greatest season for focusing is during the winter and especially along the southeast (90-120° azimuth). The graph also depicts that the summer months have a low probability of focusing, with the maximum focusing occurring along the southeast (90-120° azimuth). The sound amplification during the summer months occurred at 1.7 kilometers (1.05 miles) and beyond 7 kilometers (4.34 miles) with 20 dB above expected reading (probably due to focusing). Figure 46b illustrates spring and autumn polar distribution of average sound attenuation for 40 Hz frequency. These figures show decibel contours of 40, 50, 60, 70, and 80 attenuation and indicate that attenuation is the greatest towards the west. This increased attenuation seems to be caused by increasing of the north, northwest and westerly winds.

## TABLE 16 NOISE LEVEL AND RELATIVE LOUDNESS OF TYPICAL NOISES IN INDOOR AND OUTDOOR ENVIRONMENTS[1]

| $L_A$ (dBA) | Subjective Impression | Community (outdoor)[2] | Home/Industry (indoor) | Relative Loudness (human judgment of different sound levels) |
|---|---|---|---|---|
| 130 | | Military jet aircraft with afterburner from aircraft carrier at 50 ft (130 dBA) | Oxygen torch (121 dBA) | 32 times as loud |
| 120 | Uncomfortably loud | Turbofan aircraft at take-off power under flight path at 200 ft (118 dBA) | Riveting machine (110 dBA)<br>Rock band (108 to 114 dBA) | 16 times as loud |
| 110 | | Same jet fly-over at 1000 ft. (103 dBA). Boeing 707, DC-8 at 6080 ft before landing (106 dBA). Bell J-2A helicopter at 100 ft (100 dBA) | | 8 times as loud |
| 100 | Very loud | Boeing 737, DC-9 at 6080 ft before landing (97 dBA). Motorcycle at 25 ft (90 dBA) | Newspaper press (97 dBA) | 4 times as loud |
| 90 | | Car wash at 20 ft (89 dBA). Prop. plane fly-over at 1000 ft (88 dBA). Diesel truck, 40 mph at 50 ft (84 dBA). Diesel train, 45 mph at 100 ft (83 dBA) Power mower at 25 ft (85 dBA) | Food blender (88 dBA)<br>Milling machine (85 dBA)<br>Garbage disposal (80 dBA) | 2 times as loud |

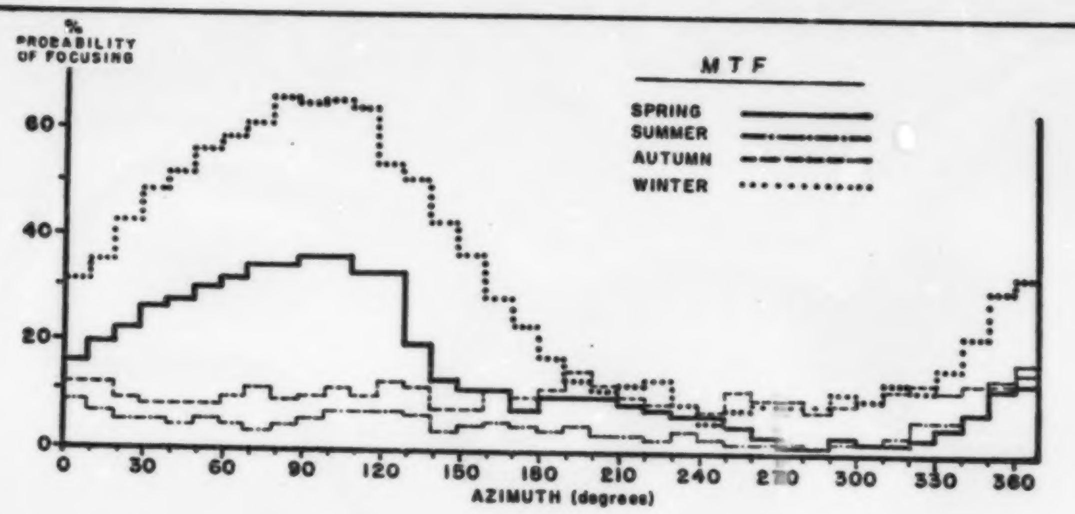
TABLE . 16 CONTINUED[1]

| $L_A$ (dBA) | Subjective Impression | Community (outdoor)[2] | Home/Industry (indoor) | Relative Loudness (human judgment of different sound levels) |
|---|---|---|---|---|
| 80 | Moderately loud | High urban ambient sound (80 dBA) Passenger car, 65 mph at 25 ft (77 dBA). Freeway at 50' from pavement edge 10 a.m. (76 ± 6 dBA) | Living room music (76 dBA) TV-audio, vacuum cleaner (70 dBA) | Reference Loudness |
| 70 | | | Cash register at 10 ft (65-70 dBA). Electric typewriter at 10 ft (64 dBA). Dishwasher, rinse at 110 ft. (60 dBA) Conversation (60 dBA) | 1/2 as loud |
| 60 | | Air-conditioning condensing unit at 15 ft (55 dBA) Large transformers at 100 ft (50-60 dBA). | | 1/4 as loud |
| 50 | Quiet | Bird calls (44 dBA). Lower-limit urban daytime ambient noise (40 dBA). | | 1/8 as loud |
| 40 | | [Scale interrupted] | | 1/16 as loud |
| 10 | Just Audible Threshold of Hearing | | | |
| 0 | | | | |

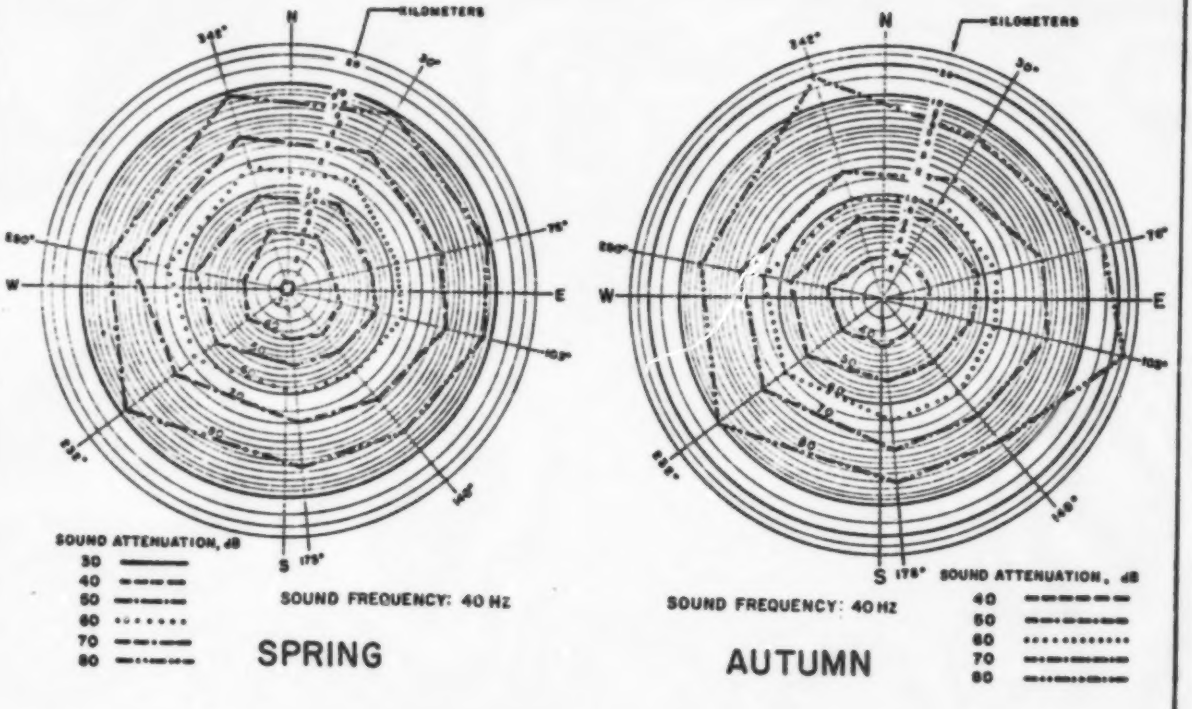
---

[1] L.L. Beranek, 1971.

[2] Numbers in parentheses are A-weighted levels.



a-PROBABILITY OF SOUND FOCUSING BY AZIMUTH THE MTF



b-POLAR DISTRIBUTION OF AVERAGE SOUND ATTENUATION AT THE MTF

Modified from REISIG, 1965

Figure 46

## Orbiter Single Engine Static Test

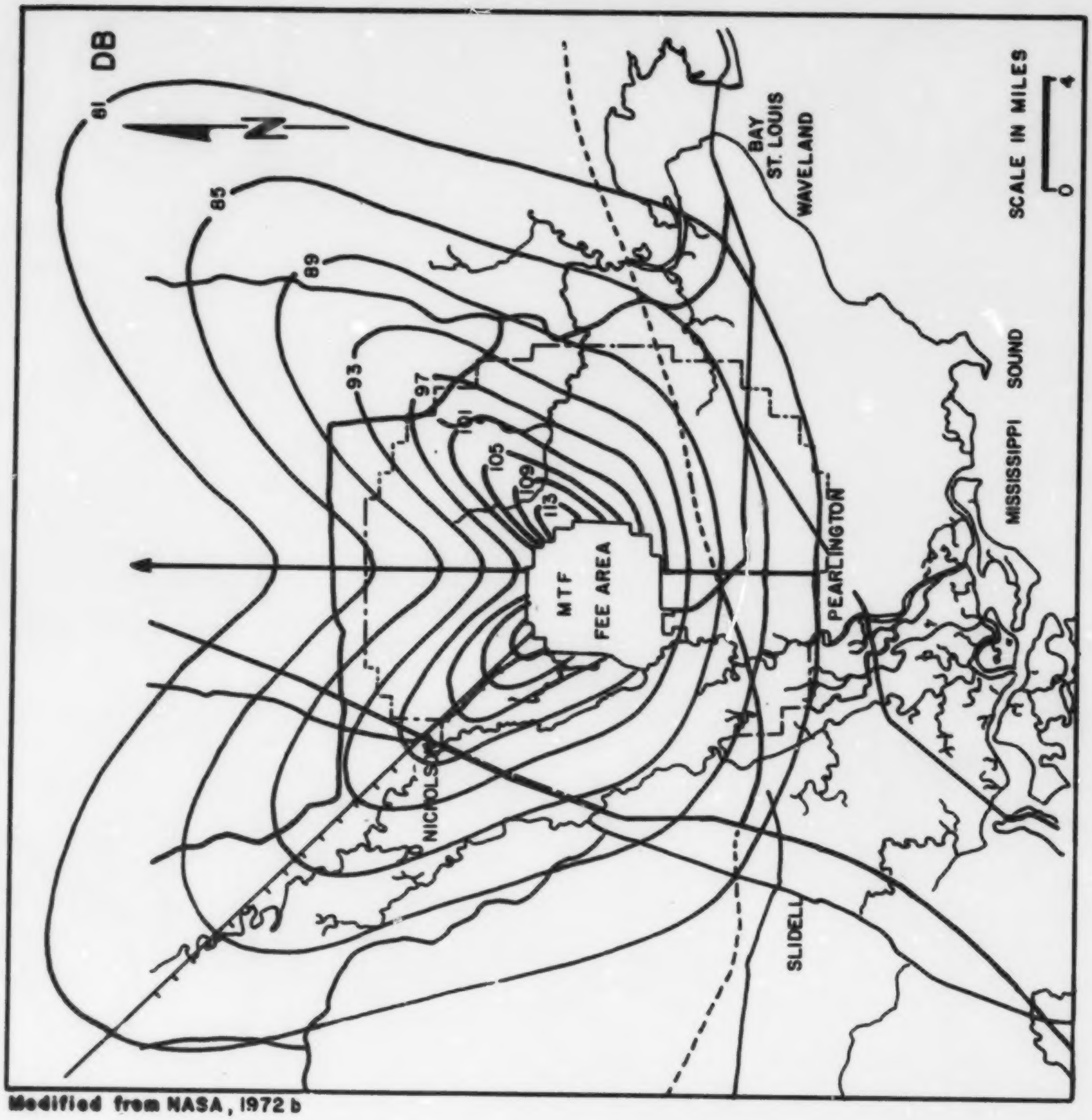
The Orbiter single engine static test enabled actual demonstration to verify the conclusions of the acoustical experiment conducted by NASA. Figure 47 illustrates the maximum overall pressure level contours inside and outside of the Buffer Zone of the MTF. Emphasis was directed to possible excessive noise levels propagated to Interstate Highway 10. It was determined that during the static firing of the Orbiter single engine, the reading would be only 90dB and would not be hazardous to travellers passing through this region.

## Air Pollution at the MTF

It has been observed that the major pollutants in Southwest Mississippi are derived directly or indirectly from combustion of fossil fuels. Products from combustion of fuels have been divided into two categories. The main sources of visual pollution are particulate substances which form smoke and dust. The second category includes substances which are chemically active in the atmosphere. A few of these pollutants are CO, PAN, HC, $O_3$, NO, $SO_2$, particulates and gaseous substances. The effects of these pollutants on terrestrial and aquatic biota and on human life varies depending on their toxic nature, concentration and susceptibility.

The MTF site may be an ideal study location to provide data on air pollution on a regional or local scale. A regional study could provide data to determine atmospheric dispersion from one industrial region to another, and might be used to determine toxic levels and rates of increase of toxic pollutants in the atmosphere. The radar, photographic laboratories, climatic monitoring instruments and computers, already available at the MTF, would make such a site an ideal weather corridor monitoring station in one of the most significant storm tracks in the United States (as observed in Figure 39). The MTF site might also suffice as a central data bank for possible nation-wide air pollution monitoring. The monitoring station will also aid in evaluating the success and effects of HMSE testing by utilizing incineration techniques.

Ozone ($O_3$) is one of the prime pollutants emitted as a result of incomplete combustion of fossil fuels. As a consequence, large amounts of ozone being released into the atmosphere (via automobiles, refineries, and organic processes) have resulted in producing photochemical smog. Photochemical smog has been observed in New Orleans and threatens the biota in the Mississippi. However, the effects of these pollutants have not been evaluated or monitored.



Modified from NASA, 1972 b

OVERALL SOUND PRESSURE LEVEL CONTOURS
SINGLE ENGINE STATIC FIRING AT THE MTF

Thrust = 375,000 lb. – Std. Atmosphere S&E-Aero-AU

Figure 47

The lack of background data on regional air dispersion, chemical and particulate analyses, and regional and local air circulation, suggests that modeling and monitoring of air pollutants is a necessity. The constant surveillance of airborne pollutants will establish and determine their adverse impacts on the region.

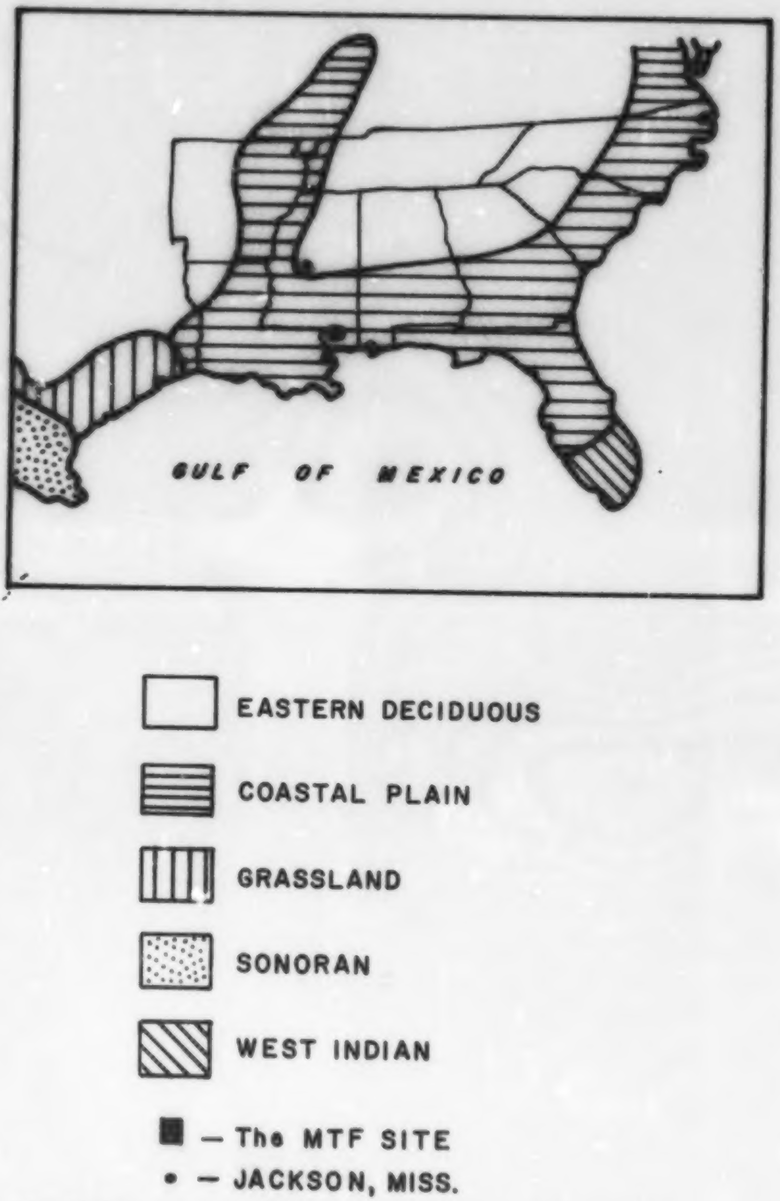
## TERRESTRIAL AND AQUATIC BIOTA IN THE MTF AREA

A brief survey of the literature indicates that regional and subregional studies dealing with the various forms of biota in Southwestern Mississippi are scarce. Ecosystem analyses are, to date, characterized as either: 1) broad-ranging and general; e.g., usually extrapolated from nearby studies in northern sections of the state or in Alabama or Georgia, or 2) detailed and limited in scope and/or area; e.g., various barrier island or coastal marshland studies. With these limitations, a series of interviews were made with persons possessing expertise in various fields of study. These interviews along with available literature descriptions were used to evaluate the various biotic forms in the MTF area.

### Terrestrial Biota -- Flora

Southwestern Mississippi and the MTF are characterized as part of the Coastal Province of Vegetation (Ref: Gleason and Cornquist, 1964) which extends along the entire northern Gulf Coast from Louisiana to Mid-Central Florida and north along the Atlantic Coast to Maryland and Delaware. The Coastal Province in the State of Mississippi generally includes all vegetative forms south of a line passing through Jackson (see Figure 48). Vegetative forms and characteristics of the Coastal Province have been summarized by Braun (1964) as follows:

> "The vegetation of this region is in part warm temperate-subtropical, in part distinctively coastal plain, and in part temperate deciduous. It is made up of a variety of widely different forest communities--coniferous, mixed coniferous and hardwood, deciduous hardwood, and mixed deciduous and broad-leafed evergreen hardwood--interrupted here and there by swamps, bogs and prairies. The large number of unlike communities is related to the diverse environmental conditions of the region. Differences in age of the land surface, and hence in degree of dissection; differences in soil materials (coastal plain deposits) and hence in topography, soil texture, and soil moisture relations; differences in fire frequency and hence in fire effects; and finally, differences in land utilization and hence in secondary communities even on adjacent and environmentally like tracts, all contribute to the multitude of communities of the region".



Modified from Gleason & Cronquist (1964)

FLORISTIC PROVINCES OF THE SOUTHEASTERN UNITED STATES

Figure 48

Braun (1964) also describes the Coastal Province as, in part, a transitional to another forest formation, e.g., the Subtropical Broad-leafed Evergreen forest. The following descriptions were abstracted from Braun (1964) except where other authors are indicated. Plant communities typical of the area include:

1. Pine and Pine-Oak Forest (see Table 17 for scientific names), a wide variety of pine species (longleaf, loblolly, and slash) and oak species in various combinations and in various physiognomic forms.

   a. Longleaf Pine Forms typically occupy sandy, zeric areas either as pure or nearly pure stands or in association with other evergreen and deciduous species. (Xeric in this study, is a term relating to relatively dry or well-drained areas; as opposed to hydric, which refers to inundated or partially inundated areas.) Respective habitats include: 1) dry sandy dunes, or 2) river banks and bayous. Mixed longleaf pine forest commonly include turkey oak, upland willow oak, and blackjack oak, as a second (lower canopied) level under the longleaf pines. The more southerly Pine Hills areas are purer in nature (with occasional occurrences of other evergreens) and are usually characterized by infrequent occurrences of shrubs, small trees, and a wide variety of grasses and herbaceous plants. Longleaf pine forests generally thrive in areas frequented by fire (as well as in zeric conditions), while other pine species perish in the flames, heat, and/or dessication. Longleaf may also be found in more moist conditions; however, it does not tolerate land subject to inundation.

   b. Pine Flats, Savannahs and Bays characterize the landscape in topographically flat areas, in areas lacking stream dissection, and in areas of poor drainage caused by a subsurface hard pan layer. The coniferous vegetative components usually include longleaf pine, loblolly pine, slash pine, or pond pine in varying relationships depending on drainage variations. These mixed-pine areas are usually bordered by either (1) an open-pine-evergreen-shrub community (bay), or (2) a pine-grass-sedge community (savannah). Braun (1964) describes the substrata of the bay and savannah forms as upland bogs where there is a well-defined humus-infiltrated soil layer present, overlying a sandy soil. The bay or shrub-bogs are usually a dense tangle of evergreen shrubs, woody vines, and small trees; among which are interspersed some deciduous species. This dense growth is in turn overtopped by a scattering of loblolly and/or pond pines. In floristic composition and in prevalent growth form, these bays are regarded as part of the Subtropical

## TABLE 17

## SCIENTIFIC NAMES OF PLANT SPECIES USED IN TEXT OF TERRESTRIAL AND AQUATIC BIOTA IN THE MTF AREA$^{1,2}$

| Common Name | Scientific Name |
|---|---|
| American Holly | Ilex opaca Ait. |
| American Hornbeam | Carpinus caroliniana Walt. |
| Ash | Fraxinus sp. |
| Bald Cypress | Taxodium distichum (L.) Rich. |
| Beech | Fagus grandifolia var. caroliniana (Loud.) Fern. & Rehd. |
| Black Tupelo | Nyssa sylvatica Marsh. |
| Black Willow | Salix nigra Marsh. |
| Blackjack Oak | Quercus marilandica Muenchh. |
| Briar | Smilax spp. |
| Cane | Arundinaria spp. Michx. |
| Cow Oak | Quercus michauxii Nutt. |
| Cypress | Taxodium sp. |
| Dogwood | Cornus florida L. |
| Drummond Red Maple | Acer drummondii Hooker & Arnold. |
| Eastern Redbud | Cercis canadensis L. |
| Elm | Ulmus sp. |
| Hackberry | Celtis sp. |
| Hackberry (Sugarberry) | Celtis laevigata Willd. |
| Hickory | Carya sp. |
| Holly | Ilex sp. |
| Live Oak | Quercus virginiana Mill. |
| Loblolly Pine | Pinus taeda L. |
| Longleaf Pine | Pinus palustris Mill. |
| Louisiana Palmetto | Sabal louisiana |
| Overcup Oak | Quercus lyrata Walt. |
| Palmetto (Dwarf) | Sabal minor (Jacq.) Pers. |
| Pawpaw | Asimina triloba (L.) Dunal. |
| Pecan | Carya illinoensis (Wangenh.) Koch. |
| Pond Cypress | Taxodium ascendens Brongn. (or T. distichum var. nutans) |
| Pond Pine | Pinus rigida var. serotina (Michx.) Loud. |
| Poplar | Populus sp. |
| Post Oak | Quercus stellata Wang. |
| Prairie False Indigo | Baptisia leucantha T&G. |
| Pumpkin Ash | Fraxinus tomentosa Michx. |
| Red Cedar (Eastern) | Juniperus virginiana L. |
| Red Maple | Acer rubrum L. |
| Sassafras | Sassafras albidum (Nutt.) Nees. |
| Saw Palmetto | Serenoa repens (Bartr.) Small. |
| Shagbark Hickory | Carya ovata (Mill.) K. Koch. |
| Shingle Oak | Quercus imbricaria Michx. |
| Shortleaf Pine | Pinus echinata Mill. |
| Silver Maple | Acer saccharinum L. |
| Slash Pine | Pinus elliottii var. elliottii Little and Dorman. |

TABLE 17 (Continued)

| Common Name | Scientific Name |
|---|---|
| Sour Gum | Nyssa sylvatica Marsh. |
| Southern Magnolia | Magnolia grandiflora L. |
| Southern Red Oak | Quercus falcata Michx. |
| Southern White Cedar | Chamaecyparis thyoides (L.) BSP. |
| Spruce Pine | Pinus glabra Walt. |
| Swamp Chestnut Oak | Quercus prinus L. (or Q. michauxii Nutt.) |
| Swamp Red Oak | Quercus falcata var. pagodaefolia Ell. |
| Swamp Tupelo | Nyssa sylvatica var. biflora (Walt.) Sarg. |
| Sweet Bay | Magnolia virginiana L. |
| Sweet Gum | Liquidambar styraciflua L. |
| Sweet Red Gum | Liquidambar styraciflua L. |
| Sycamore | Platanus sp. |
| Tuliptree | Liriodendron tulipifera L. |
| Tupelo Gum (Sour) | Nyssa sylvatica Marsh. |
| Turkey Oak | Quercus laevis Walt. |
| Upland Willow Oak | Quercus cinerea Michx. |
| Water Ash | Fraxinus caroliniana Mill. |
| Water Elm | Ulmus serotina Sarg. |
| Water Oak | Quercus nigra L. |
| Water Tupelo | Nyssa aquatica L. |
| White Oak | Quercus alba L. |
| Willow Oak | Quercus phellos L. |
| Yaupon | Ilex vomitoria Ait. |
| Yellow Oak | Quercus muehlenbergii Engelm. |
| Yellow Pitcher Plant | Sarracenia flava L. |
| Yerba-de-Tago | Eclipta alba (L.) Hassk. |

---

[1] Sources include Brown (1967), Braun (1964), Brockman (1968), Fernald (1950), and Lloyd and Tracy (1901).

[2] Listed in alphabetical order by common name (does not include species in list form such as Table 18).

Evergreen Forest formation. The savannah areas are characteristically park-like in appearance, and contain a wide variety of unusual and showy plants such as the yellow pitcher plant (Sarracenia flava). Present-day savannah areas are thought to be the result of destruction of former shrub-bog vegetation by man-made fires.

c. Loblolly Pine and Pine-Hardwoods Forests occupy the northern end of the Coastal Province in Mississippi, and are thought to have colonized former shortleaf and longleaf pine forests that were destroyed by previous agriculture and cuttings. These forest areas have typically moist and fertile soils. The loblolly pine and pine-hardwoods group are characterized by dominant (height and numbers) stands of loblolly pine with various scattered, intermingled or understory broadleaf species present, such as white oak, yellow oak, southern red oak, swamp red oak, post oak, swamp chestnut oak, water oak, hickory, sweet gum, sour gum, red maple, ash and holly. Yaupon is described as a common shrub associate.

d. Slash Pine forests, although a constituent of the southern longleaf pine forests, are also abundant in a narrow belt along the entire Gulf Coast. Pure stands or associations with other pines and oaks (usually evergreen species) are common. On the barrier islands and in areas characterized by sand dunes, the slash pines may become partially buried by wind-blown sand. In addition, slash pine is a constituent of hydric communities (topographic lows such as bayous) where it is associated with cypress or swamp tupelo. A multitude of small trees, shrubs and woody vines also characterize these wet areas, which are commonly supported by a substrate consisting of a deep organic muck soil overlying an impervious clay lens (Newcome, 1967).

2. Prairies and Associated Forest Communities are generally associated with calcareous belts of soils and include indicator species such as the eastern red cedar. The more northern extents include the "Black Belt" and "Jackson Prairie" in Mississippi, and in southern Louisiana an area south of the longleaf pine region. Species composition (both grasses and forbs) is usually characterized by plants normally associated with the more interior prairies to the north and west. In addition to these areas, we have made the distinction between "wet prairie" and "prairie"; the first characterized by hydric conditions such as standing water of varying depths (saline or fresh) for varying periods during the growing season. These wet prairies are characteristic of coastal marshes, bayous, river floodplains, river deltas, and lake-pond

shorelines (e.g., "salt marshes" and freshwater marshes such as those near Lake Pontchartrain in Louisiana). The term "dry prairie" or "prairie", in our study, refers to those prairies in more xeric conditions such as those in the northern parts of the Coastal Province (Black Belt, etc. ). Undisturbed prairie areas can be distinguished from savannah areas in Mississippi mainly because of the lack of a classic park-like (scattered trees with broken canopy) appearance. Prairie soils are typically high-organic in nature. Surface layers of better drained areas are peaty and dark-brown or black in color while those of poorly drained or more anaerobic conditions are characteristically fat clays mixed with silts and other materials (depending on local conditions and nearness to and type of parent materials).

3. Swamp Forests in Mississippi usually occupy topographic lows where drainage is generally poor and the soil conditions are typical of surface layers of muck overlying an impervious clayey lens. Common species identified in these areas include swamp tupelo, pond cypress, bald cypress, pone pine, slash pine, sweet bay, and southern white cedar (*Chamaecyparis thyoides*). Swamp forests in Mississippi are frequently better-drained areas and are generally referred to as upland swamp forests.

a. Bottomland Forests are usually associated with alluvial land near river areas and are typified by the Mississippi Bottoms areas. Species common to the bottomland forest include black willow, hackberry, pecan, poplar, sycamore, cypress, tupelo, gum, various oaks and hickories. Typical floodplain areas, true swamps, and bayous are covered with this type of vegetation.

b. Cypress-Tupelo Swamp Forests are characteristic of the numerous bayous and slough swamps in Mississippi. Bald cypress, water tupelo, silver maple, red maple, water and pumpkin ash, swamp tupelo, pecan, and water elm are characteristic species of the area. Bald cypress and water tupelo are indicator species which help to identify this type of forest from the alluvial swamps and bottomlands vegetation, where the indicator species are pond cypress, swamp tupelo, and pond pine.

c. Hardwood Bottoms are also referred to as glade bottoms and are characterized by dry soils (for much of the year) with periodic flooding for considerable periods. Common species include sweet (red) gum, red maple, swamp chestnut oak, cow oak, swamp red oak, shingle oak, overcup oak, willow oak, elm, sassafras, hackberry (*Celtis laevigata*), pawpaw, dogwood, and American hornbeam. The typical southerly extent of this type of forest often includes water and live oak, sweet gum, green and pumpkin ash, tupelo, and palmetto (*Sabal minor*). The forest structure is typically dense, with multiple canopy development common. Large trees, woody vines, dense shrubs, and tall grasses and herbs are also characteristic. In warmer areas (e.g., near the coastline) evergreen species of oaks and magnolias are more frequently encountered, and dense patches of cane and tangles of briars (Smilax spp.) often prevent tree reproduction.

d. Ridge Bottoms are usually strand line formations that blend into surrounding swamp forest types. Indicator species include sweet gum, white oak, shagbark hickory, pecan, beech, and magnolia. The substrate conditions are usually elevated a few feet above surrounding bottoms and are free of water most of the year. The soils are generally better-drained and better-aerated.

Although regional ecotones exist toward the northern extent of the Coastal Province, e.g., into mixed mesophytic forms, the Southwestern Mississippi area is comprised of: 1) a combination, 2) parts, and 3) ecotones of the forest communities previously described. Ecotones, when referred to in this report, are transitional areas where adjacent communities or regions are intermingled; as Braun (1964) states: "Broad ecotones always present problems in the interpretation of boundaries because of overlapping of vegetational features." To a larger extent, the region is influenced by:

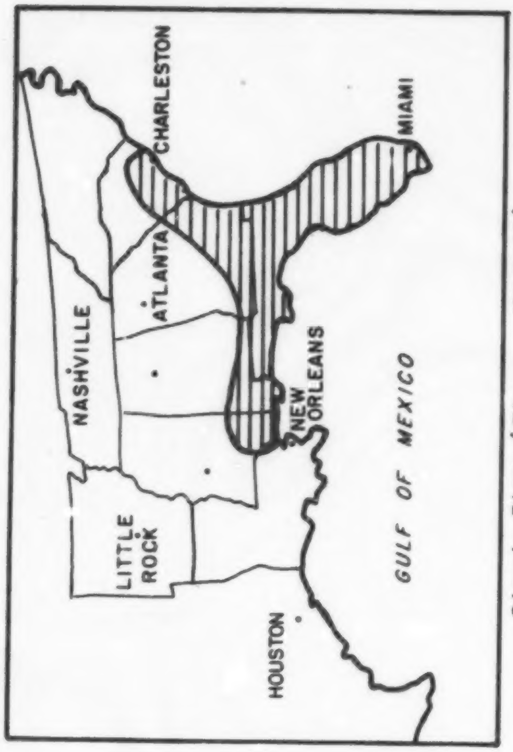
1. Coastal species such as live oak, dwarf palmetto, saw palmetto, Louisiana palmetto, various magnolias, and cane.

2. Eastern and northeastern influences, such as shortleaf pine, various oaks, maples, hickories, tuliptree, and beech.

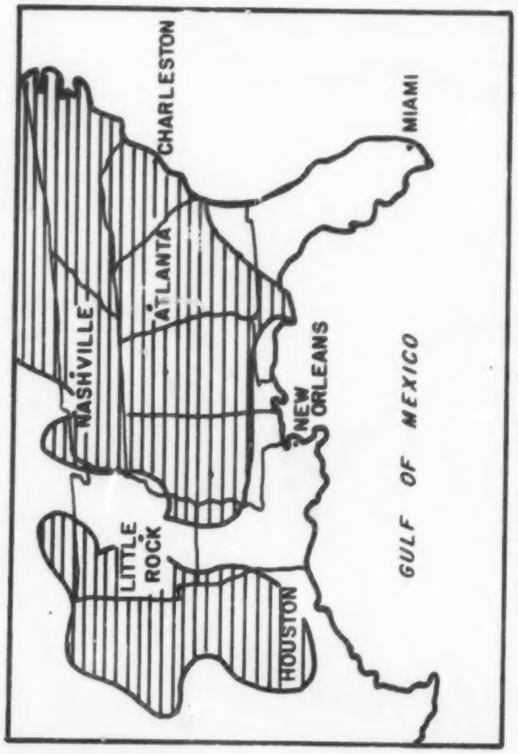
3. Western and northwestern influences, including various prairie species, such as prairie false indigo and yerba-de-tago.

In addition, the location of the MTF in relation to the Mississippi Embayment (as well as to other much varying topographic forms) enhances the site as a characteristic regional/sub-regional ecotonal area. Figures 49 and 50 show the distribution of various pine and oak species in relation to the MTF. As can be seen, the ranges of these species overlap or end at (or near) the site, thus causing the area to be theoretically subject to colonization and adaptation by a wide range of potential species. Typically, these regional-sub-regional ecotonal areas are valued as high in species diversity and low in compositional stability.

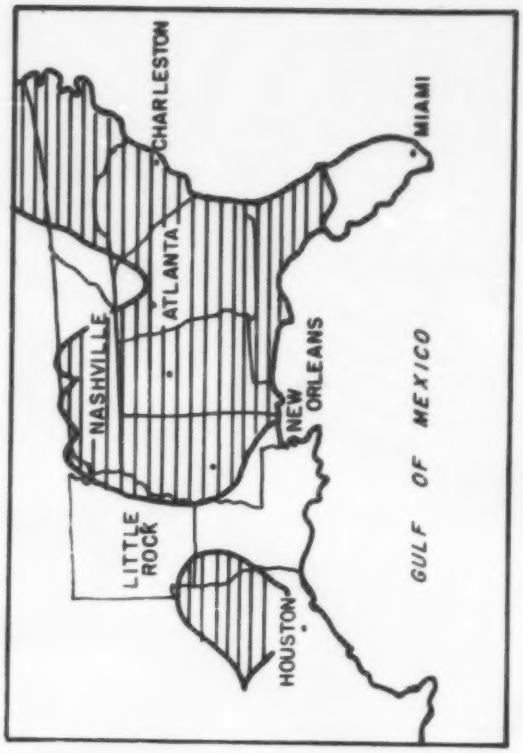
An example of the diversity of species within the Southwestern Mississippi area, as well as extension beyond normal growing conditions, can be seen in Table 18. Species in this listing extend out



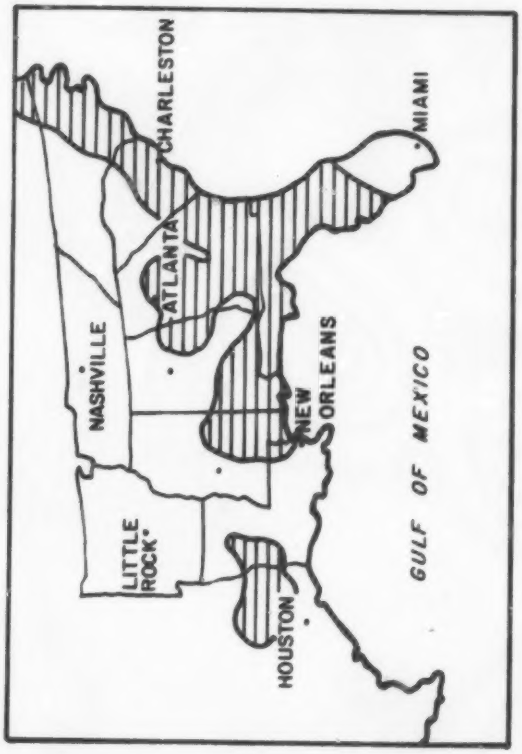
Slash Pine (*Pinus elliottii*)



Shortleaf Pine (*Pinus echinata*)



Loblolly Pine (*Pinus taeda*)

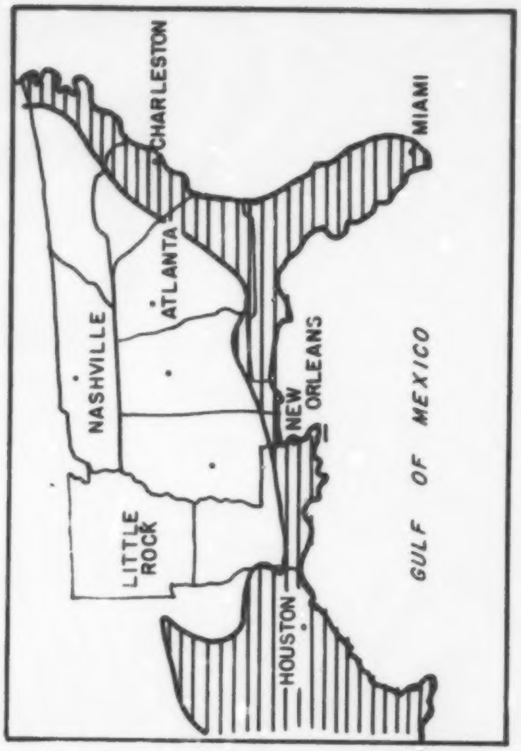


Longleaf Pine (*Pinus palustris*)

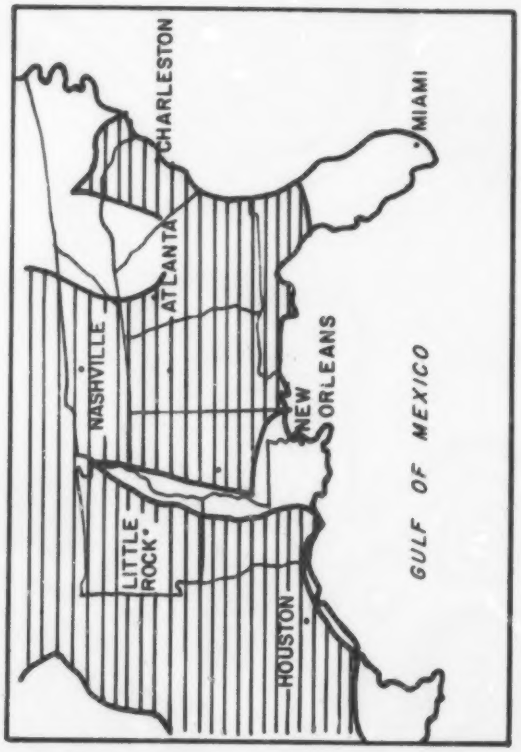
[1] Modified from Brockman (1968)

REGIONAL DISTRIBUTION OF FOUR IMPORTANT SPECIES OF PINE IN THE SOUTHEASTERN UNITED STATES[1]

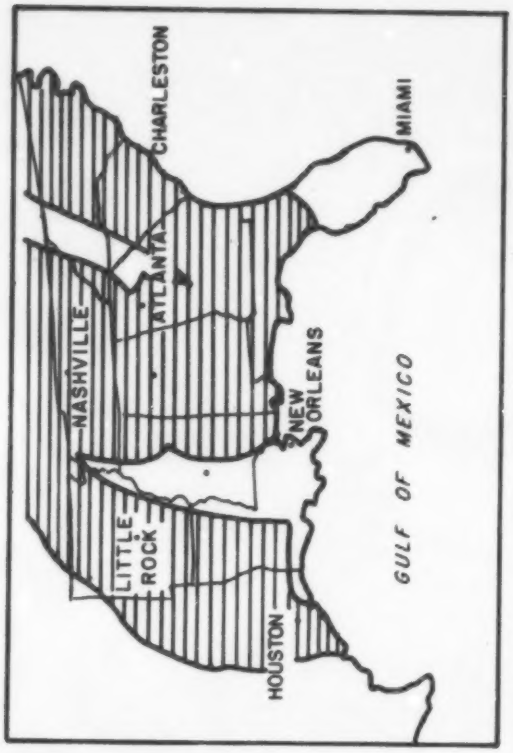
Figure 49



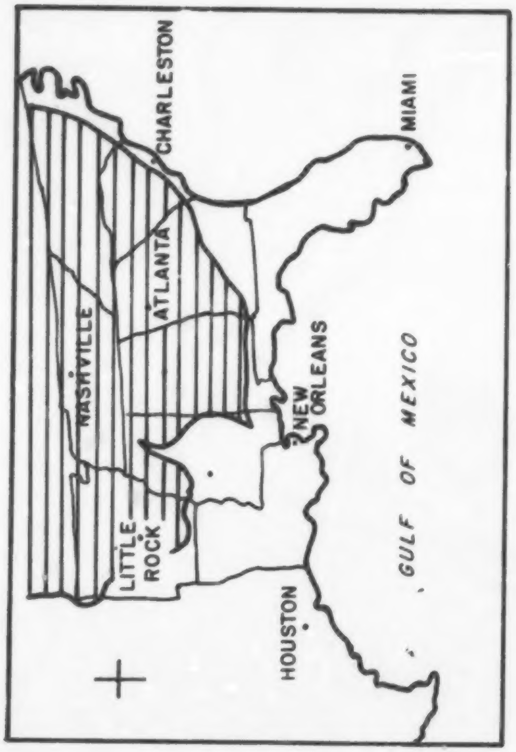
Live Oak (*Quercus virginiana*)



Shumard Oak (*Quercus shumardii*)



Southern Red Oak (*Quercus falcata*)



Northern Red Oak (*Quercus borealis*)

[1] Modified from Brockman (1968)

REGIONAL DISTRIBUTION OF FOUR SPECIES OF OAK IN THE SOUTHEASTERN UNITED STATES[1]

Figure 50

## TABLE 18

## SELECTED VASCULAR SPECIES IDENTIFIED IN DAVIS BAYOU AND ON SHIP ISLAND, MISSISSIPPI (1970)[1]

| Common Name | Scientific Name | Davis Bayou | Ship Island |
|---|---|---|---|
| Aloe Yucca | Yucca aloifolia | x | x |
| American Holly | Ilex opaca | x | |
| Briars | Smilax spp. | x | x |
| Cabbage Palmetto | Sabal palmetto | x | x |
| Eastern Redbud | Cercis canadensis | x | |
| Flowering Dogwood | Cornus florida | x | |
| Hercules Club | Xanthoxylum clava-herculis | x | |
| Honeysuckle Vine | Lonicera flava | x | x |
| Live Oak | Quercus virginiana | x | x |
| Louisiana Palmetto | Sabal louisiana | x | |
| Odorless Bayberry | Myrica inodora | x | x |
| Polypody Fern | Polypodium polypodioides | x | |
| Rushes | Juncus spp. | x | x |
| Saw Palmetto | Serenoa repens | x | x |
| Sedges | Carex spp. | x | x |
| Slash Pine | Pinus elliottii | x | x |
| Slough Grass | Spartina spp. | x | x |
| Southern Magnolia | Magnolia grandiflora | x | x |
| Southern Red Cedar | Juniperus silicola | x | |
| Southern Red Oak | Quercus falcata | x | |
| Spanish Moss | Tillandsia usneoides | x | |
| Spider Lily | Trandescantia virginiana | x | x |
| Sundew | Drosera spp. | x | |
| Sweet Gum | Liquidambar styraciflua | x | |
| Willow | Salix spp. | x | |
| Yellow Pitcher Plant | Sarracenia flava | x | |

---

[1] From Thomas and Miller (1970), all collections made in March, 1970.

of their primary community range (Ref: Braun, 1964) indicating both the presence of a broad ecotonal range, as well as the apparent ease that these species have in adapting to a wide range of growing conditions (Davis Bayou and Ship Island are generally considered part of the longleaf-slash pine community [Ref: Brown, 1967]). A similar situation has been described on Horne Island (Ref: Richmond, 1962 and 1968) where species typical of inland conditions apparently survive and reproduce quite well in an insular environment. Although Davis Bayou lies a considerable distance to the east (Ocean Springs, Miss.), definite parallels in general vegetative physiognomy and composition have been observed by the authors in areas near the Pearl River floodplain in Hancock County. In Southwestern Mississippi, detailed and accurate plant community analyses (quantitatively defined with standard plant ecological techniques) and vegetative mapping have not been completed to date. Eleutarius (1973), Pullin, (1973), and Hendry (1973) agree that quantification is needed to determine:

1. Plant communities and forest types present in the region as well as in Hancock County.
2. Indicator species and vegetative components of the various plant communities and forest types.
3. Vegetative-soil relationships of these types and communities.
4. Mapping of the above.
5. Determination of past, present, and future successional trends (with provision for future monitoring programs).

## Vegetation in the MTF Buffer and Fee Areas

The vegetative communities characteristic of the Southwestern Mississippi Counties have been defined by Brown (1967) as Longleaf-Slash Pine, with Loblolly-Shortleaf Pine and Oak-Pine areas to the north. The MTF lies completely within the Longleaf-Slash Pine area (Ref: Brown 1967), which compares to the Braun (1964) description as a combination of Slash Pine Forest and Loblolly Pine and Pine-Hardwoods Forest.

Detailed and accurate composition studies, forest type analyses, and woody segregant studies have not been performed for the entire MTF Fee and Buffer Areas. Hendry (1973) indicates the Hancock County portion of the area to be principally comprised of slash pine growth; however, our observations also indicate substantial cypress and mixed deciduous stands to the west and in scattered areas to the north and east of the Fee Area.

A preliminary appraisal of the vegetative forms of the site was performed by the Army Corps (1965), who mapped and classified the site into a system of "tree versus non-tree" forms. An appraisal of the economic value and type of management of the woody growth in the area was also made. The Army Corps (1965) listing of species encountered at the MTF included the following:

"a. The tree species native to the area consist of conifers and bottomland hardwoods. Conifers most commonly found are Longleaf, Slash and Loblolly Pines on the low flat to very gently rolling lands. Hardwood composition is primarily Black, Tupelo, and Red Gums, Water Oaks, Swamp White Oaks located in the East Pearl River, creek and intermittent branch bottomlands. The most common species of trees are as follows:

1) Longleaf Pine (Pinus palustris)
2) Slash Pine (Pinus elliottii)
3) Loblolly Pine (Pinus taeda)
4) Spruce Pine (Pinus glabra)
5) Cypress (Taxodium distichum) [Taxodium distichum]
6) Black Gum (Nyssa sylvatica) [Black Tupelo]
7) Swamp Tupelo Gum ( Nyssa biflora) [Nyssa sylvatica var. biflora] [Additional notes or corrections made based on Fernald (1950), Braun (1964) or Brown (1967)]
8) Tupelo Gum (Nyssa acquatica) [Water Tupelo]
9) Southern Red Oak (Quercus falcata)
10) Black Oak (Quercus velutina)
11) Sweet Gum (Liquidambar styraciflua)
12) White Oak (Quercus alba)
13) Water Oak (Quercus nigra)
14) Red Maple (Acer rubrum) or [Acer drummondii]
15) Live Oak (Quercus virginiana)
16) Post Oak (Quercus stellata)
17) Blackjack Oak (Quercus marilandica)
18) Green Ash (Fraxinus pennsylvanica var. lanceolata) [var. subintegerrima]
19) Bitternut Hickory (Carys cordiformis)
20) Bitter Pecan (Carya texana)
21) Pecan (Carya pecan) [C. illinoiensis]
22) Winged Elm (Ulmus alata)
23) Magnolia (Magnolia grandiflora)
24) Sweetbay (Magnolia virginiana)
25) Beech (Fagus gradifolia)
26) American Holly (Ilex opaca)
27) Youpon Holly (Ilex vomitoria)
28) Flowering Dogwood (Cornus Florida)
29) Persimmon (Diospyros virginiana)

30) Tooth-ache Tree (Zanthoxylum clavaherculis)
[Xanthoxylum clava-herculis)
31) Redbud (Cercis canadensis)
32) Black Cherry (Prunus serotina)
33) Southern Crab Apple (Malus anqustifolia)
34) Tung Oil Tree (Aleurites fordii)
35) River Birch (Betula nigra)
36) Blue Beech (Carpinus caroliniana)
37) Eastern Hophornbeam (Ostrya virginiana)

"b. The shrubs common to the locality are:

1) Gallberry (Ilex glabra)[I. coriacea]
2) Dwarf Wax Myrtle (Myrica pumila)
3) Arrowwood Veburnun (Vernurnum dentatum)
[Arrow-wood Viburnum][Viburnum dentatum]
4) Winged Sumac (Rhus copallina)
5) Swamp Azalea (Rhododendrum viscosum)
6) Poison Sumac (Rhus vernix)
7) Sweetbay Magnolia (Magnolia virginiana)
8) Southern Maxmyrtle (Myrica certifera)[M. cerifera]
9) Marsh Elder (Iva fruteschens) [Iva frutescens]
10) Buttonbush (Cephalanthus occidentalis)
11) Swamp-privet (Forestiera acuiminata) [F. acuminata]
12) Summer Azalea (Rhododendron serrulatum)
13) Winterhuckleberry (Vaccinium arboreum)
14) Parsley Hawthorn (Crataegus marshalli)
[C. marshallii]
15) Witchhazel (Hamamelis virginiana)
16) Palmetto (Sabal minor)"

In addition, the Buffer Area was classified into four physiognomic classifications, the results of which are given below:

| Forest Type | Danger Area | Non-Danger Area | Acres to Re-Forest in Non-Danger Area | Total Acres |
|---|---|---|---|---|
| Pine | None | 9,090 | 100 | 9,090 |
| Hardwood | None | 1,400 | None | 1,400 |
| Pine & Hardwood | None | 591 | None | 591 |
| Open | None | 319 | None | 319 |
| | | 11,400 | 100 | 11,400 |

The "Forest Type" is adapted directly from Army Corps (1965). The "Danger Area" classification does not include acreage being utilized in the Saturn Complex Area and supporting building facilities areas. The "Open" land category is to be utilized for wildlife feeding areas.

The total acreage of the four classes above were then appraised based on the following breakdown:

"1. Total Woodland Area set up for management: 11,400 acres"

The following data are based on timber inventory volumes found in Forestry Consultants Timber Appraisal of International Paper Company holdings consisting of approximately 11,268 acres in the Fee Area and cursory survey of the small private ownerships in the Fee Area. Scribner Log Rule was used in computing sawtimber volumes and Standard Cord (128 cu.ft.) for pulpwood volumes. The pulpwood values are adapted directly from Army Corps (1965) material.

"2. Total estimated merchantable volume:

| | |
|---|---|
| Sawtimber: | 3,345,000 Board Feet |
| Pine | 1,018,000 Board Feet |
| Total Sawtimber Volume | 4,363,000 Board Feet |
| Pulpwood: | |
| Pine | 15,350 Cords |
| Hardwood | 5,290 Cords |
| Total Pulpwood Volume | 20,640 Cords |

"3. Acres planned to reforest: 100 Acres

"4. Calculated allowable harvest for the initial cutting cycle (in Estimated Volume):

| | |
|---|---|
| Pine Pulpwood | 6,000 Cords |
| Hardwood Pulpwood | 700 Cords |

"5. Years in cutting cycle: 6 years

"6. Estimated operating costs for the initial cutting cycle (1968-1973): $50,000.00

"7. Estimated value of products to be harvested during the initial cutting cycle: $31,400.00

"8. Acres burned by wildfire during Government's tenure of ownership: no record"

It has been determined that the Army Corps'(1965) description of the MTF forest community is incomplete in terms of a comprehensive wildlife management program. Herbaceous materials, for instance, apparently were not considered in this work. Also, a community analysis by segregant type and/or compositional analysis was not indicated. Without these rudimentary studies, there is no scientific procedure available for detailed and/or comprehensive evaluation of the: 1) completeness or accuracy of species identified, 2) accuracy of the physiognomic forms analyzed, or 3) completeness of woodland inventory analyses.

This work, together with apparent discrepancies in overall community identification (Ref: Brown, 1967 vs. Braun, 1964) would lead one to believe the area has not been studied to any great degree of detail (other than through individual forestry appraisals for privately owned lands in the Buffer Zone). In addition, the various forestry techniques used in the MTF area, such as those described by Lenhart (1972), by Salter (1972), or by Wiegert (1972), could not be documented.

## Terrestrial Biota -- Fauna

The terrestrial ecosystem in the Southwestern Mississippi area is in part comprised of a rich variety of fauna. Common mammals encountered in the MTF area include (Ref: Johnson, 1973) raccoon, nutria, red and grey squirrels, rabbits, field mice, red fox, armadillo, small brown deer and wild boar. Reptiles also indigenous to the area include the black snake, green tree snake, hognosed rattler, swamp rattlesnake, cottonmouth moccasin, brown water snake, copperhead, canerattler, turtles, chameleons, and alligator. In addition, Johnson (1973) reports bird species observed in the MTF area to include the black crow, chicken hawk, owl, woodpecker, marsh duck, cardinal, blue jay, turkey buzzard, various hummingbirds, white crane, marsh crane, and various migration species of ducks.

The Army Corps (1965) reported numerous insects at the MTF site and included lists of the following species:

| Common Name | Scientific Name |
|---|---|
| Ips Engraver Beetle | Ips avulsus |
| Ips Engraver Beetle | Ips grandicollis |
| Ips Engraver Beetle | Ips calligraphis |
| Southern Pine Beetle | Dendroctonus frontales |
| Black Turpentine Beetle | Dendroctonus terebrans |
| Nantucket Pine Tip Moth | Rhyacionia frustrana |
| Pine Sawflies | Neodiprion sp. |
| White Grubs | Phyllophaga sp. |
| Pales Weevil | Hylobius pales |
| Aedes Mosquito | Aedes atlanticus |
| Aedes Mosquito | Aedes canadensis |
| Aedes Mosquito | Aedes infirmatus |
| Aedes Mosquito | Aedes sollicitans |
| Aedes Mosquito | Aedes stricticus |
| Aedes Mosquito | Aedes taeniorhynchus |
| Aedes Mosquito | Aedes triseriatus |
| Aedes Mosquito | Aedes vexans |
| Anopheles Mosquito | Anopheles atropos |
| Anopheles Mosquito | Anopheles barberi |
| Anopheles Mosquito | Anopheles bradleyi |
| Anopheles Mosquito | Anopheles crucians |
| Anopheles Mosquito | Anopheles quadrimaculatus |

| | |
|---|---|
| Culex Mosquito | Culex erraticus |
| Culex Mosquito | Culex pilosus |
| Culex Mosquito | Culex quinquefasciatus |
| Culex Mosquito | Culex restuans |
| Culex Mosquito | Culex salinarius |
| Culex Mosquito | Culex territans |
| Culiseta Mosquito | Culiseta inornata |
| Orthopoid Mosquito | Orthopodomyia signifera |
| Psorophoid Mosquito | Psorophora ciliata |
| Psorophoid Mosquito | Psorophora confinnis |
| Psorophoid Mosquito | Psorophora discolor |
| Psorophoid Mosquito | Psorophora ferox |
| Psorophoid Mosquito | Psorophora howardii |
| Psorophoid Mosquito | Psorophora varipes |
| Rutiloid Mosquito | Rutilus septentrionalis |
| Urantaeid Mosquito | Urantaenia sapphirina |

Other species are known to exist in the area and include various flies, midges, mites, bees, wasps, ants, etc., documentation of which would require an extensive survey (Ref: Borror, 1964).

## Aquatic Biota

Southwestern Mississippi provides the diverse habitat conditions for a wide variety of aquatic forms. The river and associated freshwater systems at and near the MTF provide suitable habitats for a wide variety of coastal terrace fishes (Ref: Cook, 1959), a few of which include carp, catfish, green trout, smallmouth bass, and crappe (Ref: Johnson, 1973). Anadromous forms such as various eels, sea bass, and others also frequent the area's freshwater, as well as brackish/saline water habitats. Coastal fishes near the mouths of the various rivers of the area commonly include various killifishes, sea bass, channel cats, flounder, menhaden, anchovitas, silversides, sea robins, and a wide assortment of other species.

Freshwater/brackish water invertebrates in the rivers are generally comprised of a wide variety of larval insect and macroinvertebrate forms, a few of which include various mosquito, dragonfly, and stonefly larvae: a reported 54 species of mosquitos in the combined area of Mississippi and Louisiana, 38 of which inhabit St. Tammany Parish alone (Ref: Army COE, 1965), as well as larvae of various crustaceans, such as blue crab, (Ref: Johnson, 1973) and mollusks, such as oyster. Algal forms range from sea lettuce in more saline conditions, to green and red filamentous algae in the freshwater systems. Vascular aquatic plants, although not well quantified, have been observed to range from "salt marsh" (*Spartina patens*, *Scirpus olney*, *Phragmites communi*) to various freshwater forms (Ref: Eleutarius, 1971).

## Freshwater/Saline Ecosystem Relationships

Saline water and brackish water studies in the Mississippi Sound area have, to date, concentrated on: 1) the distribution of species present, 2) the habits and habitats of species present, 3) the economic value of species present, and 4) the various micro-system studies. Wolverton (1972) stated that freshwater eutrophication and/or pollution was a potential problem, when considered in relation to various bayou and marshland conditions in the Mississippi coastline area. Being a source of nutrients (and dilution waters [Ref: Newcome, 1967]) for the Mississippi Sound, freshwater drainage reflects directly on the Sound's productivity and thus the fisheries industries along the coast. Pollutant loading has caused a problem in fishing, shellfishing, and resort uses of various areas of the Mississippi Sound. As Franks, et al. (1972) states:

> "The importance of estuarine nursery areas to commercial fishery production has been well documented in the last forty years. Relatively little attention has been given to the relationship of estuaries as generally defined to the offshore environment where all but a very few of the species comprising our estuarine dependent resources spend a part of their lives and spawn. These include, with the exception of the oysters and possibly a part of the blue crab population, nearly all of the species contributing significant production to Mississippi Landings. This project was designed for close coordination with the concurrent cooperative GMEI [Gulf of Mexico Estuarine Inventory and Study] program.
>
> "In the accounts of species encountered in offshore samples we have (loc. cit.) included some of the comparable data from GMEI samples:
>
> "McHugh (1966) wrote as follows:
>
> > 'The estuarine environment, to satisfy the fisheries scientists, must include the offshore zone affected by land drainage. Otherwise, no fishery resources other than oysters and clams can be considered entirely estuarine. Nevertheless, almost two-thirds of the United States' Commercial catch and much of the marine sport catch is composed of species that spend at least a part of their lives within the landbound estuaries'.
>
> "In the same paper McHugh suggested that:

> 'It is perhaps best to define two estuarine zones, 'inshore estuary'...and the 'offshore estuary' which is that region of the open sea in which the surface waters are measurably diluted by land drainage. The offshore limit of this zone has been defined arbitrarily as the 33.5 percent isohaline.'

"Although detailed relationships of the inshore and offshore data must await further study, a few observations are in order now. The results of this study have shown that all of our stations should be included in the "offshore estuary" as defined by McHugh (1966). The highest annual mean surface salinity....was 32.9 ppt [parts per thousand] at the 50-fathom stations. Fisheries production and management in these areas are inextricably linked.

"About 65 percent of the 179 species collected in this project have been observed in the Mississippi Sound."

In relation to the use of the MTF as a HMSE testing site, very careful consideration should be given to the delicate aquatic (and secondarily terrestrial) ecosystem changes which might occur. Changes in nutrient levels, sediment loads, and/or flow volumes could result in changes in composition, range, and/or herbivor-predator relationships in downstream areas, such as at the saline/freshwater interfaces of the drainage systems of the MTF. A careful inventorying and monitoring of the streams (and various locations downstream) would be essential in determining standards and guidelines for open-ended ecosystem tests.

In addition, future studies should incorporate the uncollated data and findings of Brown (1970) as well as any other unpublished theses on the MTF area. Also, it would be advantageous to borrow upon the local expertise available from institutions such as the Gulf Coast Research Laboratory and Mississippi State University.

## MTF FACILITIES AND STRUCTURES

Table 19 lists and describes the existing Mississippi Test Facility buildings and structures. The data in this table are based on information from the 1971 MTF Master Plan, the New Mississippi Test Facility 1972, and from various on-site interviews and observations. The classifications and table format have been arranged both to update and to parallel that of the 1971 Master Plan (pp. 17-22). The 172 buildings and structures have been listed with various short descriptions as follows:

1. Facility Number - Numerical designation or identifying symbol assigned to the structure (Refer to the Map, Figure 51, for locations).

# Table 19 The MTF--BUILDINGS & STRUCTURES [1,2]

| Facility Number | Facility Name | Class | Block Plan | Year Built | # of Floor | Building Area Gross | Building Area Net | Fire Rating | Phys. Cond. | Current Primary Use | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1000 | Data Handling Ctr. | PERM | 6 | 1965 | 3 | 29215 | 23763 | 4 hrs. A | Good | Data Processing | Net area includes 4384 sq. ft. mechanical floor load 2nd floor--200 PSF |
| 1001 | Data Handling Ctr. Cooling Tower | PERM | 6 | 1965 | N/A | N/A | N/A | N/A | Good | Cooling Tower | |
| 1100 | Engr. & Admin. Bldg. | PERM | 6 | 1965 | 3 | 139160 | 116427 | 4 hrs. A | Good | Admin. Bldg. | Net area includes 28302 circulation 63% office, 15% food service. |
| 1101 | Engr. & Admin. Cooling Tower | PERM | 6 | 1965 | N/A | N/A | N/A | N/A | Good | Cooling Tower | |
| 1105 | Electronic instrumentation & matl. lab. | PERM | 6 | 1965 | 1 | 58171 | 53539 | N/C | Good | Laboratory | Net area includes 16264 sq. ft. mech. & circulation 15% office, 63% laboratory, 11% stge. |
| 1106 | Cooling Tower (Bldg. 1105) | PERM | 6 | 1965 | N/A | N/A | N/A | N/A | Good | Cooling Tower | |
| 1107 | Bottle Tank Area (Bldg. 1105) | PERM | 6 | 1966 | N/A | N/A | N/A | N/A | Good | Nitrogen Stge. | Utilizes part of 3% $LN_2$ for various test purposes. |
| 1110 | Acoustics Lab. | PERM | 6 | 1965 | 1 | 6106 | 3526 | 4 hrs. A | Good | Sonic Measuring | 35% office, 22% technical, 37% misc. equip. |
| 1111 | Acoustics Lab. Cooling Tower | PERM | 6 | 1965 | N/A | N/A | N/A | N/A | Good | Cooling Tower | |
| 1200 | Central Control Bldg. | PERM | 6 | 1965 | 2 | 23237 | 19926 | 4 hrs. A | Good | Control Pt. for Test Complex | Net area includes 11892 sq. ft. mech. & circulation 13% office, 33% conference, 25% technical. |
| 1201 | Communications Bldg. | PERM | 6 | 1964 | 1 | 10562 | 7616 | 4 hrs. A | Good | Site-wide Telephone Exchange | 12% office, 65% misc. equip., 11% stge. |
| 1202 | Central Control Cooling Tower | PERM | 6 | 1965 | N/A | N/A | N/A | N/A | Good | Cooling Tower | |
| 1203 | Communications Bldg. Cooling Tower | PERM | 6 | 1964 | 1 | N/A | N/A | N/A | Good | Cooling Tower | |
| 2101 | Emerg. Services Bldg. | PERM | 3 | 1964 | 1 | 17139 | 12595 | N/A | Good | Fire Protection, Security, Medical, & Transportation | Mezzanine ceiling height--17 ft., 6 in. |
| 2105 | Mobile Equip. Maintenance Bldg. | PERM | 3 | 1965 | 1 | 34884 | 29331 | N/A | Good | Maintenance Operation | Shop area 150 PSF, 10,000 lb. wheel load, 8% office, 67% shop. |
| 2106 | Paint Stge. Bldg. | PERM | 3 | 1966 | 1 | 163 | 150 | 4 hrs. A | Good | Paint Stge. | |
| 2107 | Fuel Stge. Tank Area, Mobil Equip. Bldg. | PERM | 3 | 1966 | N/A | N/A | N/A | N/A | Good | Fuel Stge. | |
| 2201 | Site Maintenance Bldg. | PERM | 3 | 1964 | 1 | 52380 | 43237 | N/C | Good | Maintenance Shops | 11% office, 75% shop, 8% stge. |
| 2202 | Compressed Gas Cylinder Bldg. | PERM | 3 | 1965 | 1 | 5945 | 5827 | N/C | Good | Compressed Gas Bottle Stge. | |
| 2203 | Flammable Matl. Stge. Bldg. | PERM | 3 | 1964 | 1 | 8902 | 8326 | N/C | Good | Flammable Bottle Gas Stge. Area | 3% office, 81% stge., 5% rec. & shipping. |
| 2204 | Warehouse Bldg. | PERM | 3 | 1964 | 1 | 176792 | 131631 | N/C | Good | Matl. Stge. Site, Receiving | 32'-6" side bay, shop 12' 10-ton crane, ten cranes, 50 ft. hook hgt., high bay |
| 2205 | Test Maintenance Bldg. | PERM | 3 | 1965 | 2 | 45112 | 37075 | N/C | Good | Maintenance Shop | 90% shop, 10% stge., 150 PSF mezzanine. |
| 2206 | Paint Shop Bldg. (Bldg. 2201) | PERM | 3 | 1965 | 1 | 1365 | 1264 | N/C | Good | Paint Shop | |
| 2207 | Salvage Matl. Bldg. | PERM | 3 | 1966 | 1 | 4262 | 4199 | N/C | Good | Salvage Matl. Stge. | |
| 2208 | Warehouse Bldg. Cooling Tower | PERM | 3 | 1964 | N/A | N/A | N/A | N/C | Good | Cooling Tower | |
| 2310 | Lock & Bridge Equip. Bldg. | PERM | 7 | 1965 | 1 | 961 | 822 | N/C | Good | Lock & Bridge Equip. Shelter | Net area includes 585 sq. ft. mech., 61% office, 17% stge. |
| 2311 | Lock Water Supply Pump Station | PERM | 7 | 1965 | N/A | 565 | 565 | N/C | Good | Lock Pump Equip. Shelter | |
| 2312 | Potable Water Well Pump House #2 | PERM | 6 | 1965 | 1 | 169 | 169 | N/C | Good | Pump Equip. Shelter | Pump housed is 1600 ft. deep, water at 30-40 psig. |
| 2315 | Lock Control House No. 1 | PERM | 7 | 1965 | 1 | 288 | 288 | N/C | Good | Lock Equip. Control | Navigation lock is 660 x 110 ft. |
| 2316 | Lock Control House No. 2 | PERM | 7 | 1965 | 1 | 288 | 288 | N/C | Good | Lock Equip. Control | |
| 2317 | Bascule Bridge Control Bldg. | PERM | 7 | 1965 | 1 | 288 | 288 | N/C | Good | Bridge Control | Bridge is amenable to railroad extension at ctr. line. |
| 2401 | Construction Matl. Dock | PERM | 4 | 1964 | N/A | N/A | N/A | N/A | Good | Docking Facility RP-1 Fuel Transfer | |
| 2402 | RP-1 Transfer Dock | PERM | 4 | 1965 | N/A | N/A | N/A | N/A | Good | Dock | Land/water interface at RP-1 distribution system. |
| 2403 | Service Bldg. Construction Dock | PERM | 4 | 1964 | 1 | 392 | 228 | 4 hrs. A | Good | Office Space | |
| 2404 | Elevated Water Tank #1 | PERM | 3 | 1965 | N/A | N/A | N/A | N/A | Good | Water Tank | Capacity--300,000 gals. |
| 2405 | Elevated Water Tank #2 | PERM | 6 | 1965 | N/A | N/A | N/A | N/A | Good | Water Tank | Capacity--300,000 gals. |
| 2406 | Elec. Substation RP-1 Dock | PERM | 4 | 1965 | N/A | N/A | N/A | N/A | Good | Electrical Power | |
| 3101 | South Security Control Ctr. | PERM | 7 | 1966 | 1 | 5674 | 4238 | 4 hrs. A | Good | Security Control Point | Net area includes 2252 sq. ft. circulation, 63% office, 35% conference. |
| 3102 | Guard House (South) | PERM | 7 | 1966 | 1 | 100 | 96 | N/C | Good | Security Control Point | |
| 3110 | Main Transformer Sub-Station | PERM | 7 | 1964 | N/A | N/A | N/A | N/A | Good | Transformer Yard | |
| 3201 | Cyro-Barge Service Bldg. | PERM | 7 | 1965 | 1 | 3246 | 2443 | N/C | Good | Barge Service & Maintenance | 1-ton hoist 9'-6" hook hgt., 10,000 lb. wheel load, 7% office, 61% shop, 24% stge. |
| 3202 | S-IC Stage Stge. Bldg. | PERM | 7 | 1965 | 2 | 52577 | 50270 | N/C | Good | Stage Stge. | 10,000 lb. wheel load 53'-6" hook hgt., 10-ton crane. |
| 3203 | S-II Stage Checkout & Stge. Bldg. | PERM | 7 | 1965 | 2 | 87490 | 69973 | N/C | Good | Stage Checkout and Stge. | |
| 3204 | Central Heating Plant | PERM | 6 | 1964 | 1 | 10445 | 9752 | N/C | Good | Hi-Temp Water to Test Complex | Net area includes 9233 sq. ft. mechanical. |
| 3205 | Fuel Oil Stge. Tank Area (3204) | PERM | 6 | 1964 | N/A | N/A | N/A | N/A | Good | Fuel Stge. | |

# Table 19 (cont'd)

| Facility Number | Facility Name | Class | Block Plan | Year Built | # of Floor | Building Area Gross | Building Area Net | Fire Rating | Phys. Cond. | Current Primary Use | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3206 | Nitrogen & Air Stge. Tank Area (3202) | PERM | 7 | 1965 | N/A | N/A | N/A | N/A | Good | Hydrogen Stge. | |
| 3207 | Sewage Lagoon #2 | PERM | 7 | 1965 | N/A | N/A | N/A | N/A | Good | Sewage Lagoon | |
| 3208 | Central Heating Plant Cooling Tower | PERM | 6 | 1964 | N/A | N/A | N/A | N/A | Good | Cooling Tower | |
| 3220 | Scale Bldg. | PERM | 6 | 1965 | 1 | 225 | 192 | N/C | Good | Weigh Station | |
| 3305 | Central Compressor Bldg. | PERM | 9 | 1964 | 1 | 12586 | 11397 | N/C | Good | Liquid to Gas Conversion | Net area includes 6188 sq. ft. mechanical, 4% office, 77% shop. |
| 3306 | Hydrogen Compressor Shelter | PERM | 9 | 1965 | 1 | 800 | 800 | N/C | Good | Shelter for Hydrogen Compressor | |
| 3307 | RP-1 Control Bldg. | PERM | 6 | 1965 | 1 | 413 | 413 | N/C | Good | RP-1 Control | 52% technical, 48% shop. |
| 3308 | RP-1 Stge. Tank | PERM | 6 | 1965 | N/A | N/A | N/A | N/A | Good | RP-1 Stge. | Capacity--650,000 gals. |
| 3309 | $LN_2$ Tank (West) | PERM | 9 | 1965 | N/A | N/A | N/A | N/A | Good | Nitrogen Stge. | Capacity--55,000 gals. |
| 3310 | GHe Tank Ctr. (3305) | PERM | 9 | 1965 | N/A | N/A | N/A | N/A | Good | GHe Stge. Tank | Capacity--350,000 scf. |
| 3311 | GHe Tank East (3305) | PERM | 9 | 1965 | N/A | N/A | N/A | N/A | Good | GHe Stge. Tank | Capacity--350,000 scf. |
| 3312 | Potable Water Well Pump House #1 | PERM | 6 | 1965 | 1 | 169 | 169 | N/C | Good | Pump Equipment Shelter | Shelters a 1600-ft. well; pressure of 30-40 psig. |
| 3314 | Central Compressor Bldg. Cooling Tower | PERM | 9 | 1964 | N/A | N/A | N/A | N/A | Good | Cooling Tower | |
| 3315 | Hot Water Generator | PERM | 9 | 1965 | N/A | N/A | N/A | N/A | Good | Nitrogen Vaporization | Capacity--8,744,000 Btu/hr. |
| 3316 | Hot Water Generator | PERM | 9 | 1965 | N/A | N/A | N/A | N/A | Good | Nitrogen Vaporization | Capacity--8,744,000 Btu/hr. |
| 3317 | $LN_2$ Stge. Tank (3305) | PERM | 9 | 1965 | N/A | N/A | N/A | N/A | Good | Nitrogen Stge. Tank | Capacity--15,000 gals. |
| 3318 | $LN_2$ Stge. Tank | PERM | 9 | 1965 | N/A | N/A | N/A | N/A | Good | Nitrogen Stge. Tank | Capacity--27,000 gals. |
| 3319 | $LH_2$ Stge. Tank | PERM | 9 | 1965 | N/A | N/A | N/A | N/A | Good | $LH_2$ Stge. | Capacity--50,000 gals. |
| 3320 | Hydrogen Flare Stack (3306) | PERM | 9 | 1965 | N/A | N/A | N/A | N/A | Good | Excess Hydrogen Burn-Off | |
| 3407 | $LH_2$ Control Bldg. | PERM | 7 | 1965 | 1 | 1070 | 824 | N/C | Good | $LH_2$ Control Bldg. | |
| 3408 | Hydrogen Flare Stack (LOX Stge. Area) | PERM | 7 | 1965 | N/A | N/A | N/A | N/A | Good | Excess Hydrogen Burn-Off | |
| 3409 | Substation LOX Stge. Area | PERM | 7 | 1965 | N/A | N/A | N/A | N/A | Good | Deluge Water Pump | |
| 3410 | LOX Stge. Tank | PERM | 7 | 1965 | N/A | N/A | N/A | N/A | Good | LOX Stge. | Capacity--460,000 gals. |
| 3411 | Transformer Yard LOX Stge. Area (North) | PERM | 7 | 1965 | N/A | N/A | N/A | N/A | Good | Transformer Yard | |
| 3412 | Transformer Yard LOX Stge. Area (South) | PERM | 7 | 1965 | N/A | N/A | N/A | N/A | Good | Transformer Yard | |
| 4102 | S-II Guard House | PERM | 10 | 1966 | 1 | 333 | 158 | N/C | Good | Security Check Station | 51% office, 31% misc. safety. |
| 4103 | S-II Inert Gas Stge. Area | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Inert Gas Stge. | |
| 4110 | S-II Test Control Ctr. | PERM | 10 | 1965 | 2 | 20664 | 8327 | 4 hrs. A | Good | Static Test Control | 11% office, 88% technical. |
| 4111 | S-II Hydrogen Gas Stge. Area | PERM | 10 | 1966 | N/A | N/A | N/A | N/A | Good | Hydrogen Gas Stge. | |
| 4115 | $LH_2$ Catch Tank | PERM | 10 | 1966 | N/A | N/A | N/A | N/A | Good | Emergency Dumping | Capacity--150,000 gals. |
| 4118 | Hydrogen Flare Stack S-II, A-2 | PERM | 10 | 1966 | N/A | N/A | N/A | N/A | Good | Excess Hydrogen Burn-Off | |
| 4119 | Hydrogen Flare Stack S-II, A-1 | PERM | 10 | 1966 | N/A | N/A | N/A | N/A | Good | Excess Hydrogen Burn-Off | |
| 4120 | S-II Test Stand Position A-1 | PERM | 10 | 1966 | 7 | 29392 | 22693 | 1 hr. PNC | Good | Static Test | 5% office, 32% technical, 30% shop, 25% stge. |
| 4121 | S-II, A-1 Instrumentation Tower (West) | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Instrumentation Monitoring Equip. | |
| 4122 | S-II Test Stand Position A-2 | PERM | 10 | 1965 | 7 | 29392 | 22695 | 1 hr. PNC | Good | Static Test | 5% office, 32% technical, 30% shop, 25% stge. |
| 4124 | S-II, A-1 LOX Dump Pit | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | LOX Dump Pit | |
| 4125 | Observation Bunker S-II, A-1 | PERM | 10 | 1965 | 1 | 333 | 322 | 1 hr. PNC | Good | Static Test Observation | Net area includes 194 sq. ft. construction. |
| 4126 | Observation Bunker S-II, A-2 | PERM | 10 | 1965 | 1 | 333 | 322 | 1 hr. PNC | Good | Static Test Observation | Net area includes 194 sq. ft. construction. |
| 4127 | S-II, A-2 LOX Dump Pit | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | LOX Dump Pit | Capacity--150,000 gals. |
| 4130 | S-II, A-1 Instrumentation Tower (East) | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Instrumentation Monitoring Equip. | |
| 4131 | Pyrotechnic Stge. | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Stge.Vault | Capacity--20 cubic ft. |
| 4132 | S-II, A-2 Pressure Reduction Area | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Pressure Reducing | |
| 4136 | Control Station | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Hydrogen Control Bldg. | |
| 4138 | S-II, A-2 Instrumentation Tower (West) | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Instrumentation Monitoring Equip. | |
| 4139 | S-II, A-2 Instrumentation Tower (East) | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Instrumentation Monitoring Equip. | |
| 4143 | S-II, A-2 Pressure Reducing Area | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Pressure Reducing | |
| 4146 | S-II, A-2 Pyrotechnic Stge. | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Stge. Vault | Capacity--20 cubic ft. |
| 4202 | S-IC Guard House | PERM | 10 | 1965 | 1 | 337 | 229 | 1 hr. PNC | Good | Security Check Station | 38% office, 52% misc. safety. |
| 4210 | S-IC Test Control Ctr. | PERM | 10 | 1965 | 2 | 26329 | 20409 | 4 hrs. A | Good | Control Ctr. | Net area includes 9732 sq. ft. mechanical, 24% office, 68% technical. |
| 4211 | S-IC, TCC Cooling Tower | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Cooling Tower | East & west pier--9 levels<br>Center pier--19 levels. |

# Table 19 (cont'd)

| Facility Number | Facility Name | Class | Block Plan | Year Built | # of Floor | Building Area Gross | Building Area Net | Fire Rating | Phys. Cond. | Current Primary Use | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4220 | S-IC Dual Test Stand Base & Position B-1 | PERM | 10 | 1965 | 9 | 181024 | 78106 | 1 hr. PNC | Good | Static Testing | 17% office, 7% technical, 12% shop, 35% stge., 28% misc. safety & work. |
| 4221 | S-IC Dual Test Stand Position B-2 | PERM | 10 | 1965 | 9 | N/A | N/A | 1 hr. PNC | Good | Static Testing | Square footage included in B-1. |
| 4225 | Observation Bunker S-IC, B-1 | PERM | 10 | 1965 | 1 | 357 | 340 | 1 hr. PNC | Good | Static Testing Observation | Net area includes 205 sq. ft. construction. |
| 4226 | Observation Bunker S-IC, B-2 | PERM | 10 | 1965 | 1 | 357 | 340 | 1 hr. PNC | Good | Static Testing Observation | Net area includes 205 sq. ft. construction. |
| 4227 | S-IC LOX Dump Pit | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | LOX Dump Pit | |
| 4230 | S-IC Test Control Instrumentation Tower Center | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Instrumentation Monitoring Equip. | |
| 4231 | S-IC Test Control Instrumentation Tower (East) | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Instrumentation Monitoring Equip. | |
| 4232 | S-IC Test Control Instrumentation Tower (West) | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Instrumentation Monitoring Equip. | |
| 4240 | S-IC Inert Gas Stge. Area | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Inert Gas Stge. Area | |
| 4312 | Pumphouse Potable Water Well #3 | PERM | 10 | 1965 | N/A | 450 | 450 | N/C | Good | Pumphouse | Shelters 1600-ft. well pump; capacity 30-40 psig. |
| 4313 | Pressure Tank | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | N/A | Stabilize Pressure | Capacity--10,000 gals. |
| 4320 | Industrial Water Well #1 | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Industrial Water Well | |
| 4321 | Industrial Water Well #2 | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Industrial Water Well | |
| 4322 | Industrial Water Well #3 | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Industrial Water Well | Above three industrial wells capacity--13,500 gpm |
| 4324 | Sewage Lagoon #3 | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Sewage Lagoon | |
| 4325 | Industrial Water Reservoir | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Industrial Water Reservoir | Capacity--66,000,000 gals. |
| 4400 | HPIW Emerg. Power Generating & Heating Plant Complex | PERM | 10 | 1965 | 2* | 39670 | 36319 | N/C | Good | HPIW Emerg. Power | Net area includes 36215 sq. ft. mechanical;<br>* includes mezzanine. |
| 4500 | RP-1 Stge. Tank Area | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | RP-1 Stge. | Capacity--100,000 gals. |
| 4505 | RP-1 Ready Stge. Tank Area | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | RP-1 Ready Stge. | Capacity--300,000 gals. |
| 4995 | Data Acquisition Facility | PERM | 10 | 1965 | 2 | 38002 | 20357 | 4 hrs. A | Good | Acquisition of Data During Static Test | Net area includes 13401 sq. ft. mechanical, 12% office, 78% computer. |
| 4996 | Cooling Tower | PERM | 10 | 1965 | N/A | N/A | N/A | N/A | Good | Cooling Tower | |
| 6001 | Natural Gas Metering Station | PERM | N/A | 1965 | N/A | N/A | N/A | N/A | Good | Natural Gas Metering Station | |
| 6002 | Natural Gas Odorizing Station | PERM | N/A | 1965 | N/A | N/A | N/A | N/A | Good | Natural Gas Odorizing Station | |
| 7001 | Security Control Ctr. | PERM | 1 | 1965 | 1 | 2951 | 2090 | 4 hrs. A | Good | Security Control Ctr. | Net area includes 1382 sq. ft. circulation 59% office, 38% misc. |
| 7002 | Guard House (North) | PERM | 1 | 1965 | 1 | 66 | 50 | N/C | Good | Guard House | |
| 8100 | Component Test Facility | PERM | 5 | 1965 | 1 | 64124 | 50945 | N/A | Good | Component Testing | Floor load varies from 50 PSF to 250 PSF spread footing-2000 PSI Multiple hoists (varies 8'-6" to 48 ft.). |
| 8101 | Demineralized Water Tank | PERM | 5 | 1966 | N/A | N/A | N/A | N/A | Good | Demineralized Water Stge. | |
| 8102 | Sewage Lagoon (North) | PERM | 6 | 1965 | N/A | N/A | N/A | N/A | Good | Sewage Lagoon | |
| 8103 | Holding Pond | PERM | 5 | 1965 | N/A | N/A | N/A | N/A | Good | Holding Pond | |
| 8104 | Telephone Substation | PERM | 5 | 1965 | N/A | N/A | N/A | N/A | Good | Telephone Substation | |
| 8105 | Cooling Tower (Bldg. 8100) | PERM | 5 | 1965 | N/A | N/A | N/A | N/A | Good | Cooling Tower | |
| 8110 | Cryogenic Bldg. | PERM | 5 | 1965 | 1 | 4642 | 3836 | N/C | Good | Cold Shock Testing | |
| 8201 | Meteorology Bldg. | PERM | 9 | 1965 | 1 | 2836 | 1760 | N/C | Good | Sonic Measuring | 10% office, 75% technical, 6% conference. |
| 8202 | Radio Direction Finding Antenna Dome #2 | PERM | 9 | 1965 | N/A | N/A | N/A | N/A | Good | Radio Direction Finding Antenna | |
| 8203 | Radio Direction Finding Antenna Dome #1 | PERM | 9 | 1965 | N/A | N/A | N/A | N/A | Good | Radio Direction Finding Antenna | |
| 8210 | Horn Tower | PERM | 9 | 1965 | N/A | N/A | N/A | N/A | Good | Horn Tower | |
| 8212 | Horn Control Bldg. | PERM | 9 | 1965 | 1 | 280 | 216 | N/C | Good | Horn Control Equip. Stge. | |
| 8214 | Air Receiver Tank (Horn) | PERM | 9 | 1965 | N/A | N/A | N/A | N/A | Good | Air Receiver Tank | |
| 8220 | Radar Tower | PERM | 9 | 1966 | N/A | N/A | N/A | N/A | Good | Radar Control Tower | |
| T-214 | Old Atmospheric Laboratory | TEMP | 7 | 1946 | 1 | 1910 | 1487 | 0.5/hr WF | Good | Office Space | Floor load for TEMP bldgs. is estimated. |
| T-220 | Church Bldg. | TEMP | 3 | 1947 | 1 | 1550 | 1380 | 0.5/hr WF | Good | Laboratory & Office Space | |
| T-221 | Corps of Engineers Bldg. | TEMP | 3 | 1964 | 1 | 7200 | 5077 | 0.5/hr WF | Good | Office Space | |
| T-226 | Old Telephone Bldg. | TEMP | 7 | 1945 | 1 | 1496 | 1103 | 2 hrs. ORD | Good | Office Space | |
| T-226B | Telephone Garage | TEMP | 7 | 1945 | 1 | 470 | 421 | 2 hrs. ORD | Good | Stge. | |
| T-238 | Residence | TEMP | 5 | 1945 | 1 | 864 | 684 | 0.5/hr WF | Fair | Office Space | |
| T-238B | Garage | TEMP | 5 | 1945 | 1 | 400 | 360 | 0.5/hr WF | Fair | Stge. | |

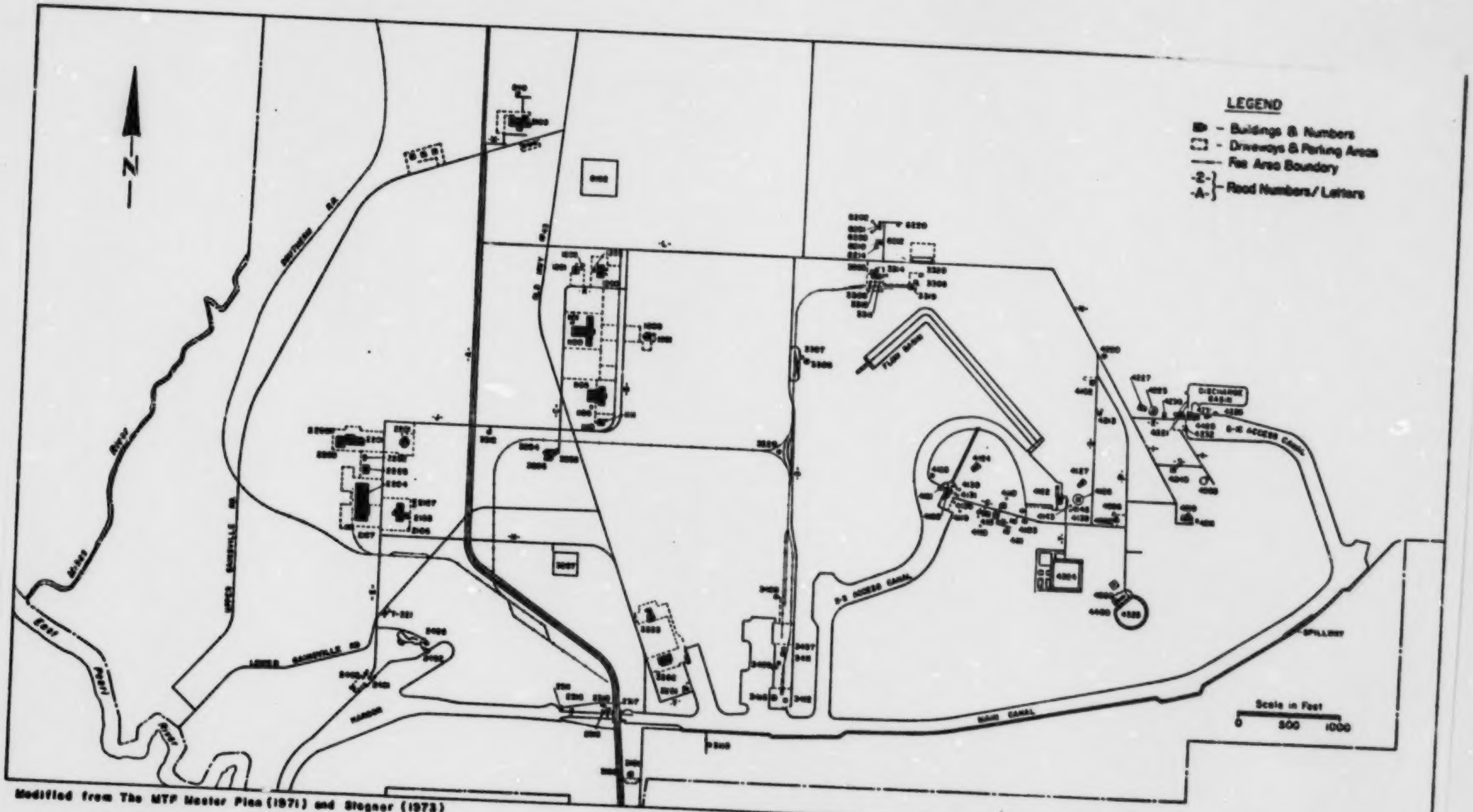
# Table 19 (cont'd)

| Facility Number | Facility Name | Class | Block Plan | Year Built | # of Floor | Building Area Gross | Building Area Net | Fire Rating | Phys. Cond. | Current Primary Use | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| T-238C | Plywood Bldg. | TEMP | 5 | 1945 | 1 | 514 | 514 | 0.5/hr WF | Fair | Stge. | |
| T-238D | Plywood Bldg. | TEMP | 5 | 1945 | 1 | 578 | 578 | 0.5/hr WF | Good | Stge. | |
| T-238E | Plywood Bldg. | TEMP | 5 | 1945 | 1 | 5031 | 5031 | 0.5/hr WF | Good | Stge. | |
| T-238F | Carpenter Shop | TEMP | 5 | 1965 | 1 | 930 | 930 | 0.5/hr WF | Poor | Stge. | |
| T-241 | Information Ctr. | TEMP | 5 | 1945 | 1 | 2730 | 2039 | 0.5/hr ORD | Good | Office | |
| T-242 | Residence | TEMP | 4 | 1940 | 1 | 1780 | 1342 | 0.5/hr WF | Fair | Vacant | |
| T-302 | Residence | TEMP | 4 | 1945 | 1 | 1850 | 1456 | 2 hrs. ORD | Good | Vacant | |
| T-302A | Garage Bldg. | TEMP | 4 | 1945 | 1 | 240 | 208 | 2 hrs. ORD | Fair | Stge. | |
| T-302B | Temporary Structure | TEMP | 4 | 1945 | 1 | 50 | 41 | 0.5/hr WF | Poor | Vacant | |
| T-302C | Summer Camp | TEMP | 4 | 1945 | 1 | 700 | 649 | 0.5/hr WF | Poor | Vacant | |
| T-309 | School Bldg. | TEMP | 4 | 1948 | 1 | 950 | 901 | 0.5/hr WF | Fair | Vacant | |
| T-314 | Residence | TEMP | 4 | 1949 | 2 | 932 | 830 | 0.5/hr WF | Poor | Vacant | |
| T-317 | Block Residence | TEMP | 4 | 1950 | 1 | 718 | 566 | 0.2/hr WF | Fair | Vacant | |
| T-323 | Church Bldg. | TEMP | 4 | 1945 | 1 | 2178 | 1527 | 0.5/hr WF | Poor | Stge. | |
| T-357 | Residence | TEMP | 4 | 1946 | 1 | 1715 | 1215 | 0.5/hr WF | Fair | Office | |
| T-360 | Block Residence | TEMP | 3 | 1945 | 1 | 924 | 792 | 2 hrs. WF | Fair | Stge. | |
| T-421 | Old Post Office | TEMP | 4 | 1946 | 1 | 300 | 268 | 0.5/hr WF | Poor | Stge. | |
| T-425 | Residence | TEMP | 4 | 1956 | 1 | 2182 | 1808 | 2 hrs. ORD | Good | Office | |
| T-428 | Residence | TEMP | 4 | 1945 | 2 | 1855 | 1479 | 0.5/hr WF | Poor | Stge. | |
| T-428B | Store Bldg. | TEMP | 4 | 1945 | 1 | 845 | 785 | 0.5/hr WF | Fair | Stge. | |
| T-428C | Open Shed | TEMP | 4 | 1965 | 1 | 1109 | 1081 | 0.5/hr WF | Fair | Stge. | |
| T-429 | Residence | TEMP | 4 | 1945 | 1 | 839 | 801 | 0.5/hr WF | Fair | Office | |
| T-429B | Garage Bldg. | TEMP | 4 | 1945 | 1 | 560 | 515 | 0.5/hr WF | Good | Stge. | |
| T-436 | Residence | TEMP | 4 | 1945 | 1 | 1512 | 1087 | 0.5/hr WF | Good | Office | |
| T-436B | Steel Butler Bldg. | TEMP | 4 | 1964 | 1 | 8312 | 6144 | 2 hrs. ORD | Good | Office | |
| T-501 | Steel Butler Bldg. | TEMP | 10 | 1964 | 1 | 3751 | 2550 | 2 hrs. ORD | Good | Office | |
| T-503 | Steel Butler Bldg. | TEMP | 4 | 1964 | 1 | 4120 | 3975 | 2 hrs. ORD | Good | Stge. | |
| T-2403A | Summer Camp | TEMP | 4 | 1960 | 1 | 322 | 296 | 0.5/hr WF | Fair | Office | |
| T-2403B | Plywood Shed | TEMP | 4 | 1964 | 1 | 234 | 210 | 0.5/hr WF | Fair | Stge. | |
| T-2403C | Plywood Shed | TEMP | 4 | 1964 | 1 | 268 | 222 | 0.5/hr WF | Fair | Stge. | |
| T-2403D | Wood Frame Shed | TEMP | 4 | 1964 | 1 | 336 | 290 | 0.5/hr WF | Fair | Stge. | |

---

[1] Modified from the MTF 1971 Master Plan (p. 17-22).

[2] Common abbreviations include the following: bldg., building; Btu, British thermal unit; ctr., center; GHe, gaseous helium; gpm, gallons per minute; HPIW, High Pressure Industrial Water; $LH_2$, liquid hydrogen; $LN_2$, liquid nitrogen; LOX, liquid oxygen; matl., material; PSF, pounds per square foot; psig, pounds per square inch guage; rec., receiving; res., reservoir; RP-1, rocket propellant no. 1; scf, standard cubic ft.; stge., storage; and other abbreviations may be found in Introduction.



Modified from The MTF Master Plan (1971) and Stogner (1973)

BUILDINGS AND STRUCTURES IN THE MTF SOUTHERN FEE AREA

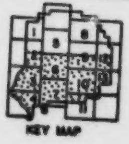


Figure 51

2. Facility Name - Commonly used name for structure.

3. Class - Refers to life expectancy of structure as follows: (a) permanent construction (25 years), (b) semipermanent construction (15 years), and (c) temporary construction (5 years).

4. Block Plan - Indicates the location of the structure in relation to the block plan system for the MTF Fee Area.

5. Year Built - Date or estimated date of completion.

6. Number of Floors - Where applicable, the number of floor levels of structure.

7. Gross Building Area - The area enclosed by outside building line.

8. Net Building Area - The gross area minus construction, circulation, and mechanical equipment space, except as noted in remarks column. Percentages of net for significant areas are also shown under remarks.

9. Fire Rating - As described in 1971 MTF Master Plan, includes the following code: (a) A or B = fire resistive types A or B, (b) PNC = protected noncombustible, (c) N/C = noncombustible, (d) ORD = ordinary, and (e) WF = wood frame.

10. Physical Condition -- arbitrary rating based on age, degree of wear and tear, and degree of structural stability.

11. Current Primary Use -- brief description of use or classified use of structure (structure may be inactive but still designated solely for this use).

12. Remarks -- essentially follow those of the 1971 Master Plan, but have been updated.

## Buildings and Facilities

Within the Fee Area shown in Figure 51, the MTF buildings complex includes (The New Mississippi Test Facility, 1972) the following:

1. More than 40 permanent buildings and structures providing over 700,000 sq. ft. of office space, 180,000 sq. ft. of warehouse space, and 185,000 sq. ft. of laboratory and shop space.

2. A navigation lock 660 x 110 ft. controlling flow and water elevation in the MTF canal system.

3. A bascule bridge controlling roadway traffic (Road A) and canal traffic with potential for development of rail traffic parallel to Road A.

4. Storage and handling facilities for liquid oxygen, liquid hydrogen, cryogenic fuels and oxidizers, other liquid fuels, pyrotechnics, and combustible and inert gases.

5. Acquisition, recording, and processing facilities for land-line and RF telemetry data.

6. Laboratory facilities including materials analysis, standards and calibration, acoustics, photography, closed circuit television and electronic equipment fabrication and repair, instrumentation and chemical and biological analysis.

7. Base support services, including fire protection, utilities, food service, reproduction, security, etc., with the capability of supporting a small city of approximately 7,500 population.

8. Fixed, mobile and portable state-of-the-art equipment, tools, machines and vehicles.

Although a wide variety of tenants operate in the same building (e.g., Building 1100 [Engineering and Administration Bldg.] -- NASA, USGS, Coast Guard, etc.), the overall function of the building usually remains the same. Where changed, Table 19 reflects these modifications.

## Transportation Systems

Transportation systems at MTF include various permanent or temporary structures, such as roads, rails, canals, etc. Within the Fee Area there are (The New Mississippi Test Facility 1972) 35 miles of highways and roads, 13 miles of operating railways, 7.5 miles of navigable canals, plus nearby Stennis Airfield (4500 ft. runway).

### Roads

The "Major Roads Plan" of MTF (1971 Master Plan) indicates that all hard surfaced roads serving functional areas such as docks, warehouse and test stands are classed as primary (wheel load capacity of 12,000 lbs.) and include principal roads such as A, E, J, B, L and N. Road A is a four-lane highway serving as the principal north-south axis of transportation in the Fee Area (Road A is also serviced by bascule bridge at the canal area). Secondary roads (wheel load capacity of 10,000 lbs.) designed for lighter traffic are being incorporated into the primary, hard surfaced Master Road Plan; the remaining unimproved or gravel surfaced roads are given very little maintenance and provide limited access to various forested area, ponds, and general maintenance developments. In addition to these on-site roadways, Interstate 10 crosses the southern Buffer Zone area and provides quick access to New Orleans (as well as to Mobile, Alabama, when completed).

## Railroads

On-site railroad connections (Figure 51) consist of a 400,000 lb. capacity railroad and highway scale, 110 ft long, near the Railroad Wye Turn-around (Bldg. 3220) as well as 5 miles of spur lines and 1.5 miles of flood-lighted parallel track in the marshalling yard. The railroad, Southern Railway Company, has connections in Nicholson, La., with other railway systems (see Regional Transportation). The railway system was originally utilized to deliver shipments of propellants, cryogenics, and other materials to MTF. Since the gearing down of the Apollo Rocket Testing program, much of the utility of the rail system has not been taken advantage of. General maintenance of the system is low-level, but geared for almost immediate full-scale use.

## Waterways

Waterway transportation at MTF includes approximately 7 miles of canal inside the Fee Area boundaries, with secondary canals extending to the Cryogenic Storage Area, the Stage Storage Area, the S-II Test Area, and the S-IC Test Area. The canals were originally designed for the shipping of machinery and materials during the MTF construction as well as the transport of large volumes of propellants and the Saturn and Apollo stages. The canal system has a normal depth of 15 ft. and a bottom width of 150 ft. At least nine government-owned propellant barges and one high wheel-housing tug were employed to move materials between Michoud and MTF.

The on-site waterway system is connected to the East Pearl River (dredged to a mimimum width of 150 ft. and depth of 12 ft. below mean low-water elevation of -0.83 mean sea level). Curves in the river were modified for a mimimum 600 ft. radius and thus made amenable for large shallow draft vessel usage. Bridges along the 21 mile course of the improved Pearl River were also modified for water transportation and include:

1. I-10-[illegible] clearance of 73 ft. at mean high water stage of 7.4 ft. x 115 ft.

2. US 90--a swing bridge with horizontal clearance of 96.5 ft.

3. Louisville Nashville Railroad--a swing bridge with horizontal clearance of 158.75 ft.

In addition, power lines, locks, piers and other channel improvements were made to facilitate the flow of waterway traffic. Access of this system to the Gulf Intercoastal Waterway System provides direct connections to New Orleans (Michoud Assembly Facility) as well as to various points east and south. The waterway system at MTF is one of the site's major assets, and provides direct waterway access to the Hancock County Port Facility area (see Regional Transportation).

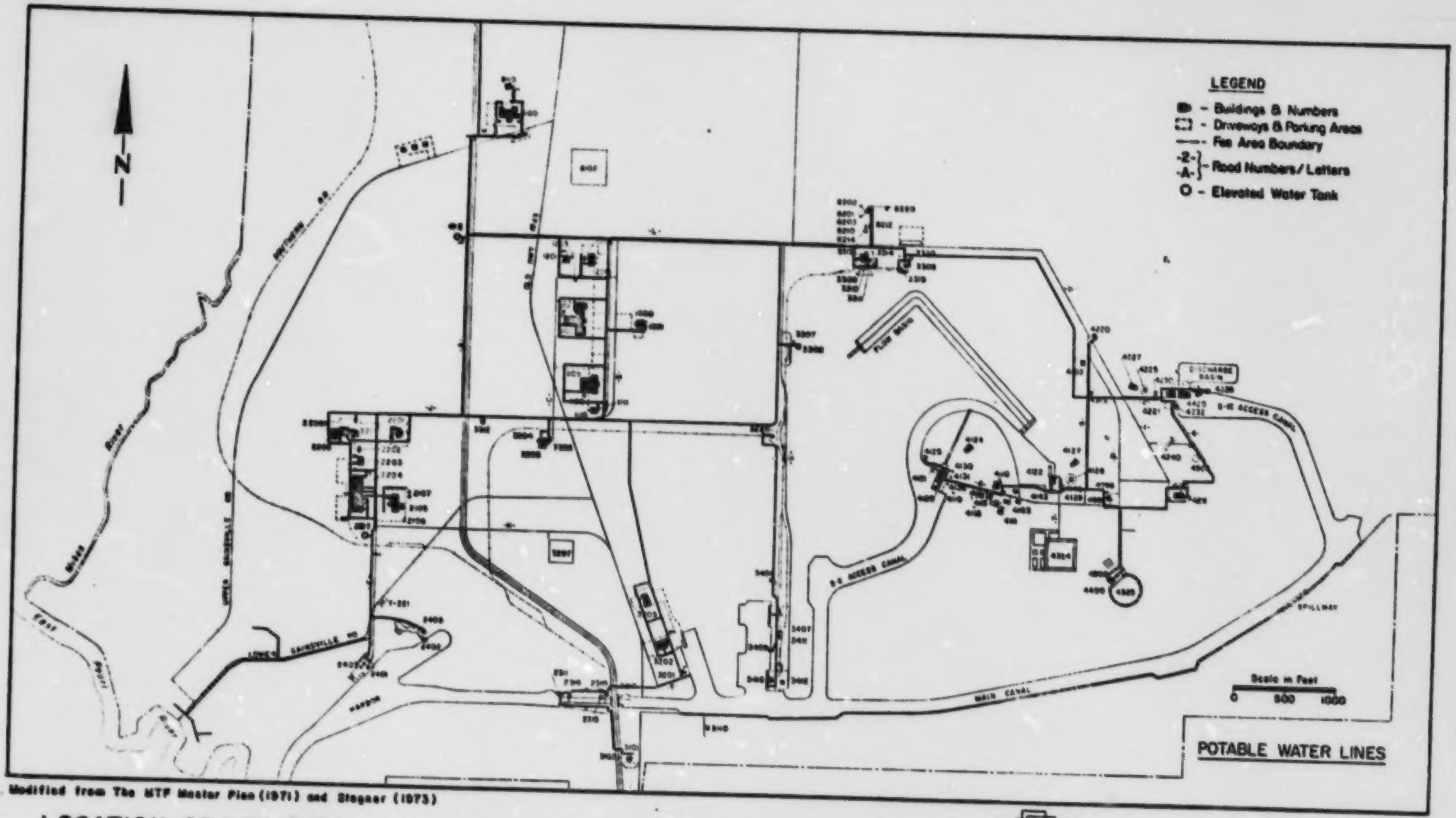
### Air Transport

Air transportation in the MTF regional area is well-developed and provides easy and rapid access to the site. The close locations of the Stennis Airfield, the Biloxi-Gulfport Airport, and New Orleans International Airport provide rapid access from all major cities in the United States and Mexico. Jet airline service is regularly available to both New Orleans and Biloxi-Gulfport, and local charter service or land transport connections (via I-10 or US 90) can be easily made. A more detailed description of regional air transport can be found in "Baseline Aspects: Region and Area." Accessibility to transport is another valuable asset of the MTF area.

## MTF UTILITIES AND SERVICES

Twelve utility systems and various support systems at MTF are described. Figures 52 through 63 illustrate the locations of the twelve principal utility developments at MTF in the following order:

Fig. 52 -- Potable Water System
Fig. 53 -- High Pressure Industrial Water System
Fig. 54 -- Sanitary Sewerage Systems
Fig. 55 -- High Temperature Hot Water/Chilled Water Systems
Fig. 56 -- Electrical Distribution System
Fig. 57 -- Natural Gas System
Fig. 58 -- High Pressure Air System
Fig. 59 -- Hydrogen System
Fig. 60 -- Helium System
Fig. 61 -- Liquid Oxygen System
Fig. 62 -- Nitrogen System
Fig. 63 -- RP-1 System



Modified from The MTF Master Plan (1971) and Stagner (1973)

## LOCATION OF UTILITIES SYSTEMS IN THE MTF SOUTHERN FEE AREA

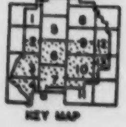
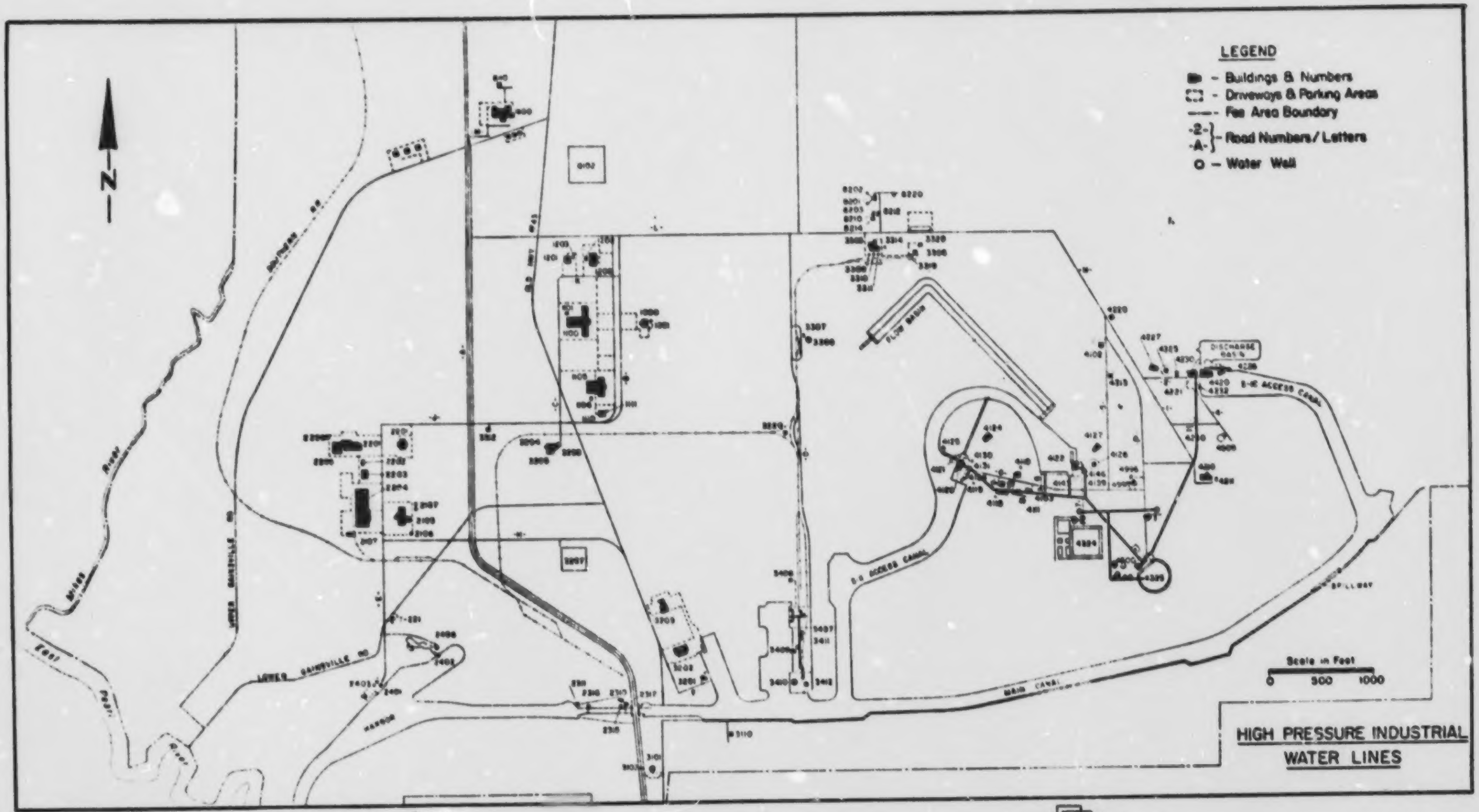


Figure 52



Modified from The MTF Master Plan (1971) and Stegner (1975)

LOCATION OF UTILITIES SYSTEMS IN THE MTF SOUTHERN FEE AREA

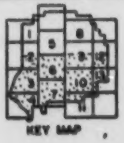
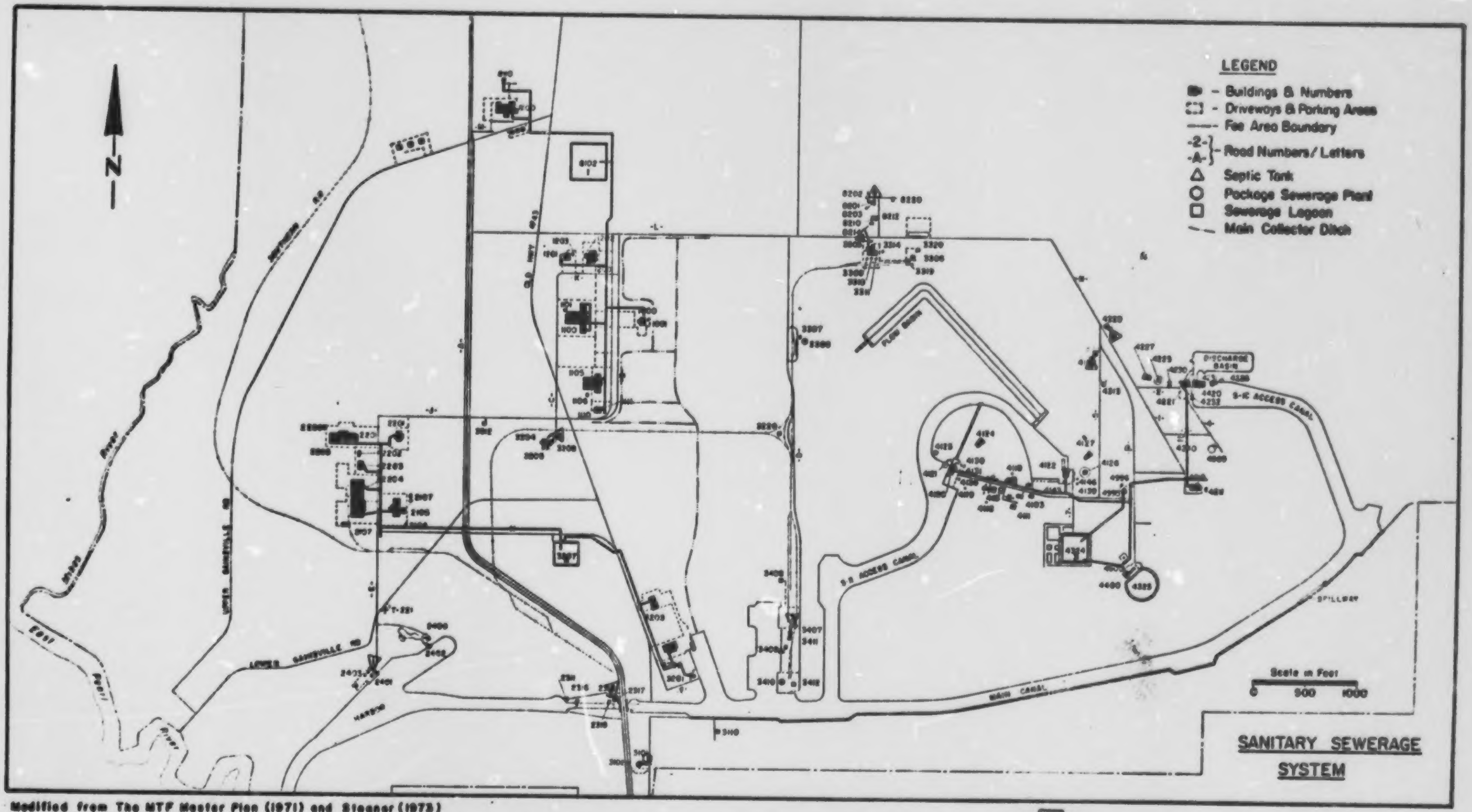


Figure 53



Modified from The MTF Master Plan (1971) and Stagner (1973)

LOCATION OF UTILITIES SYSTEMS IN THE MTF SOUTHERN FEE AREA

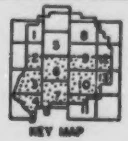
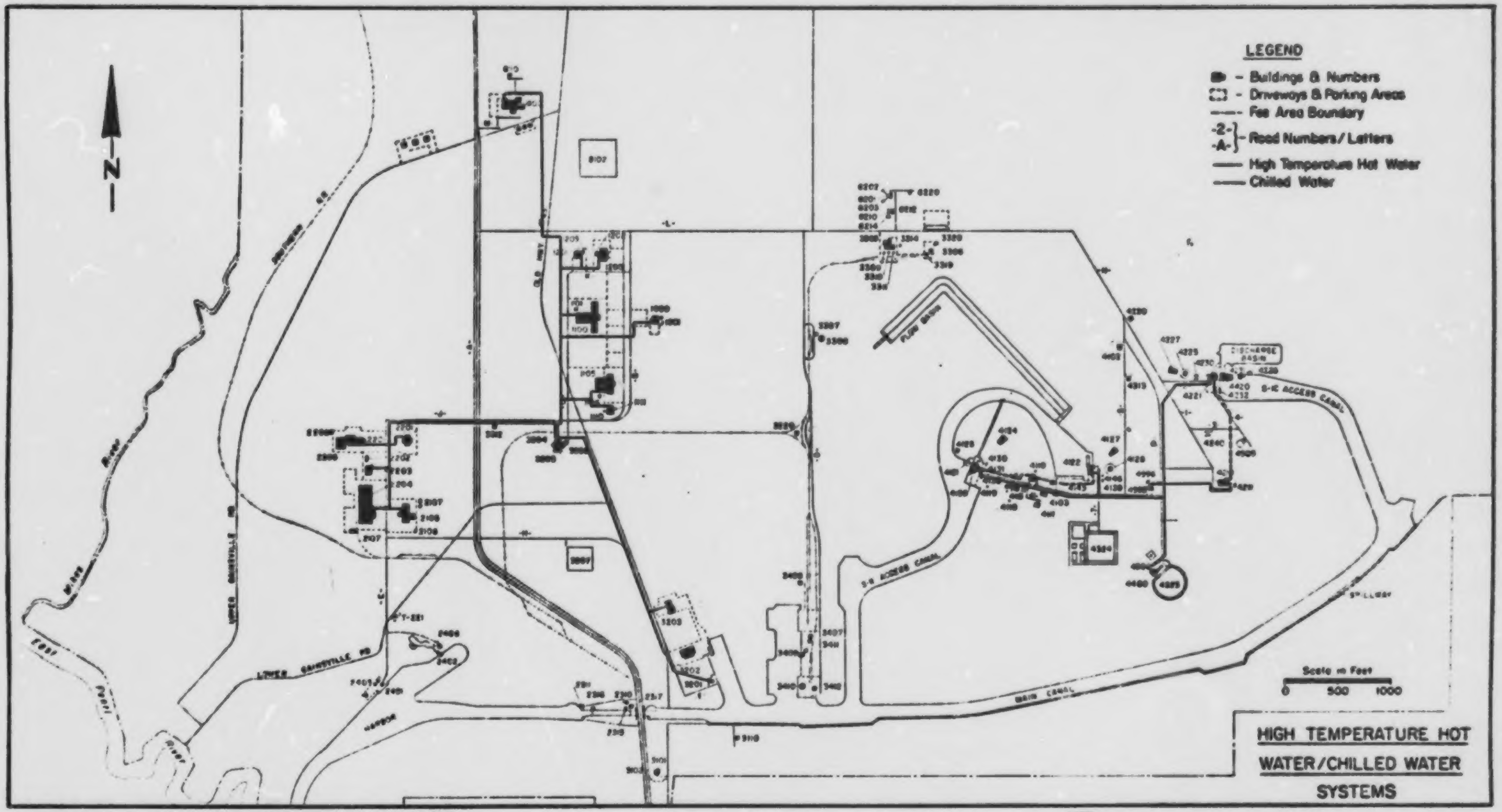


Figure 54



Modified from The MTF Master Plan (1971) and Stogner (1973)

LOCATION OF UTILITIES SYSTEMS IN THE MTF SOUTHERN FEE AREA

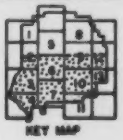
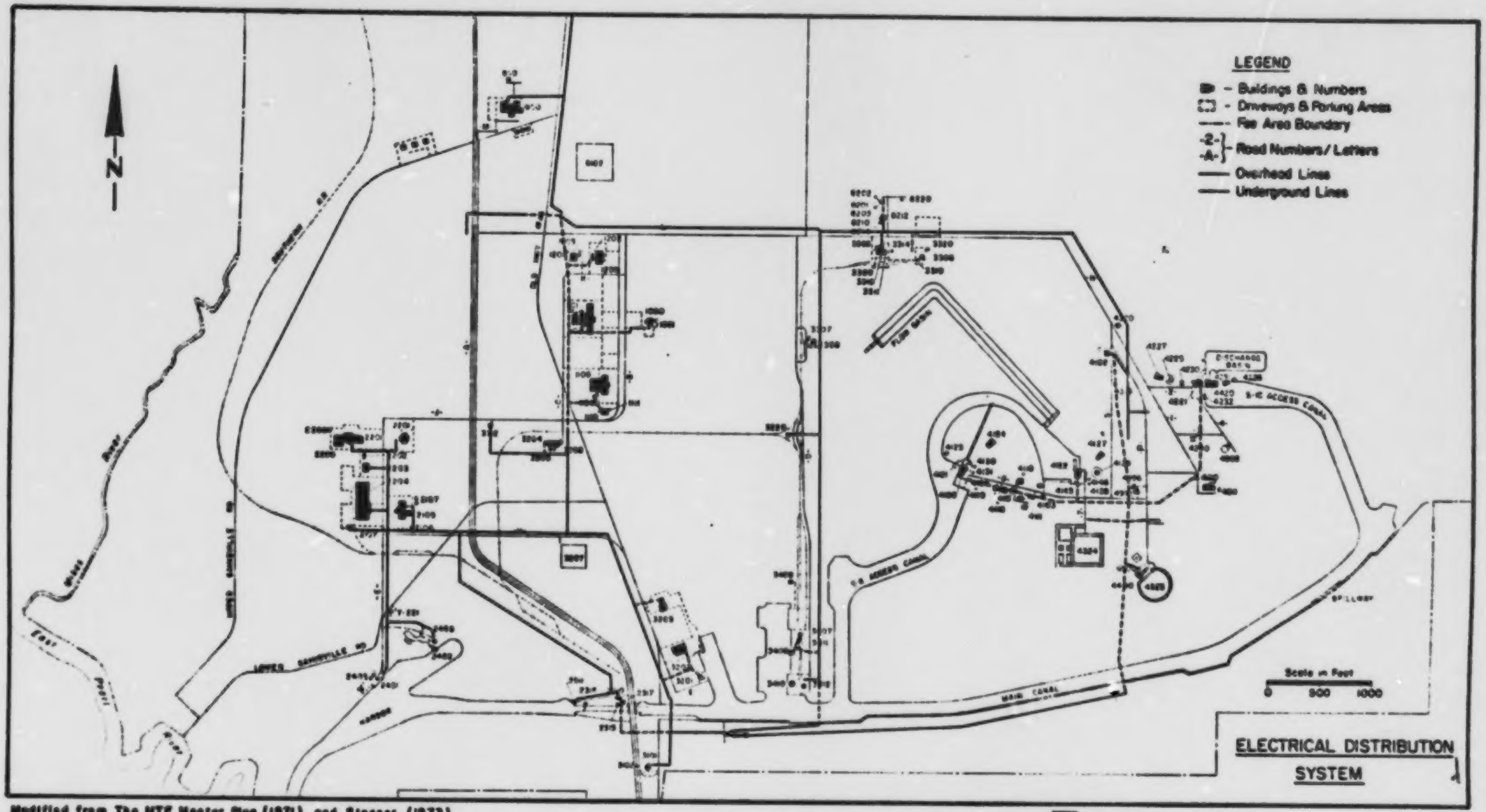


Figure 55



Modified from The MTF Master Plan (1971) and Stogner (1973)

LOCATION OF UTILITIES SYSTEMS IN THE MTF SOUTHERN FEE AREA

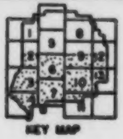
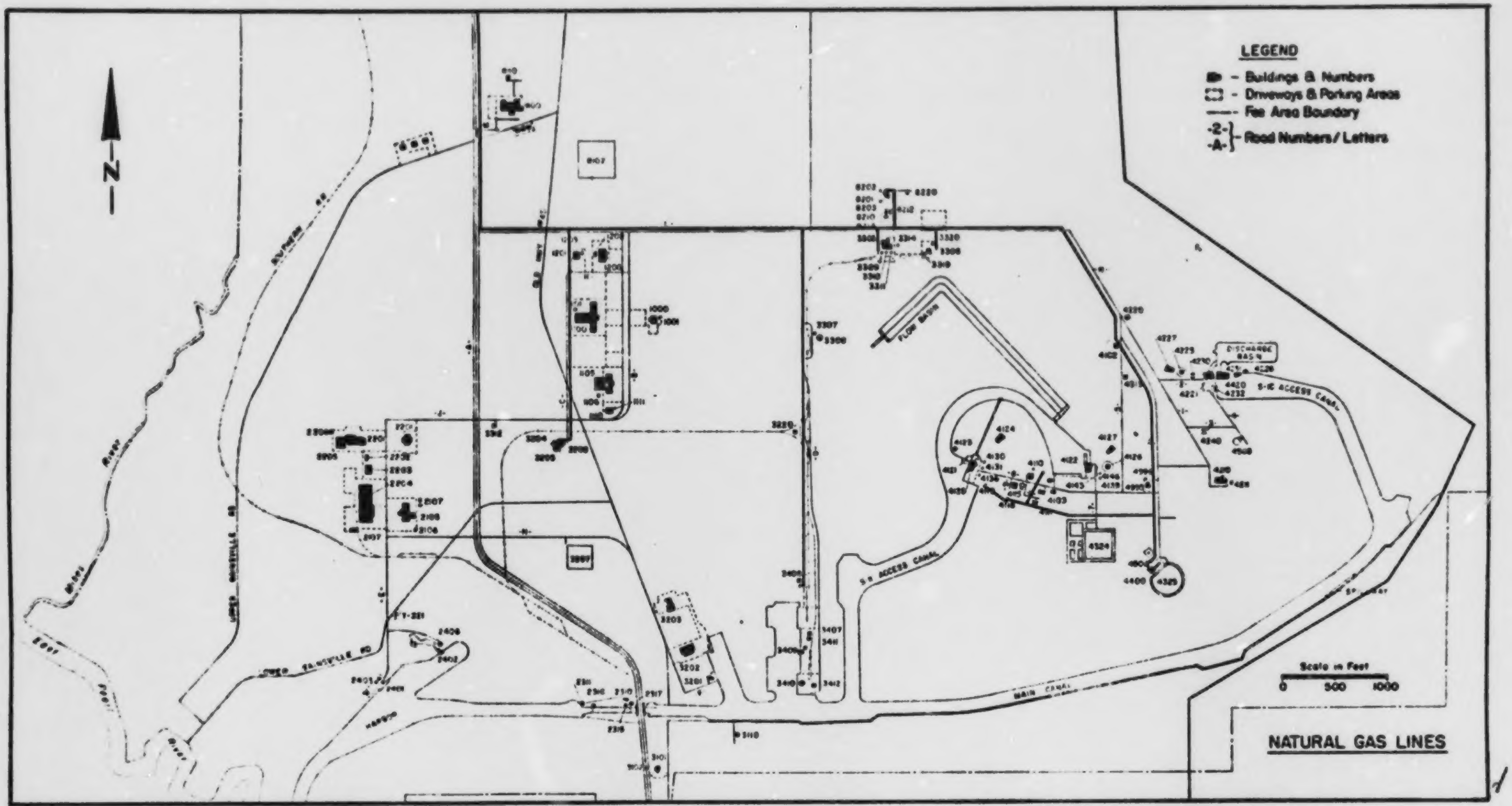
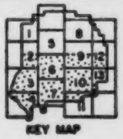


Figure 56



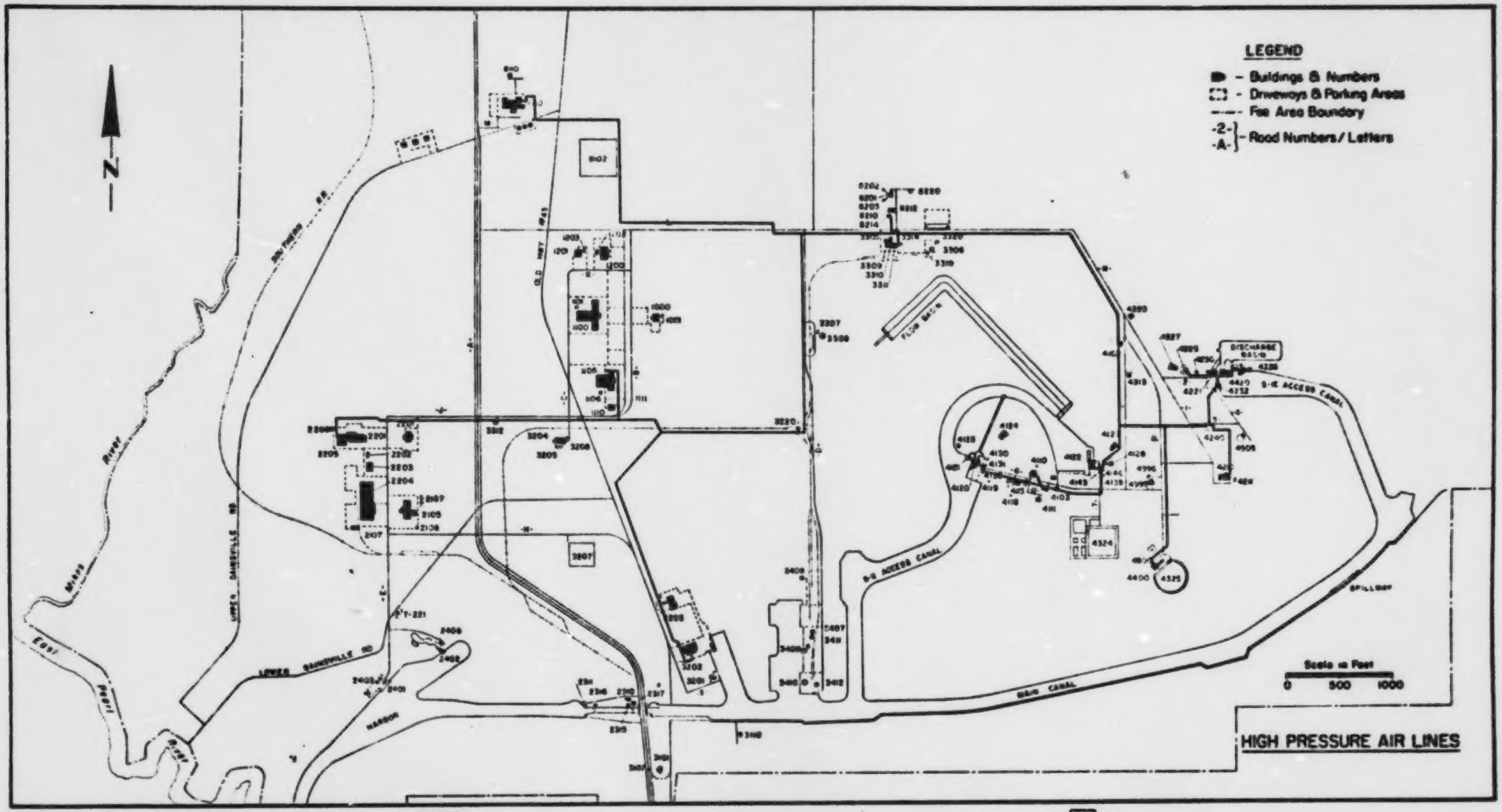
Modified from The MTF Master Plan (1971) and Stogner (1973)

LOCATION OF UTILITIES SYSTEMS IN THE MTF SOUTHERN FEE AREA



KEY MAP

Figure 57



HIGH PRESSURE AIR LINES

Modified from The MTF Master Plan (1971) and Stogner (1973)

LOCATION OF UTILITIES SYSTEMS IN THE MTF SOUTHERN FEE AREA

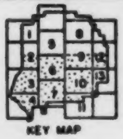
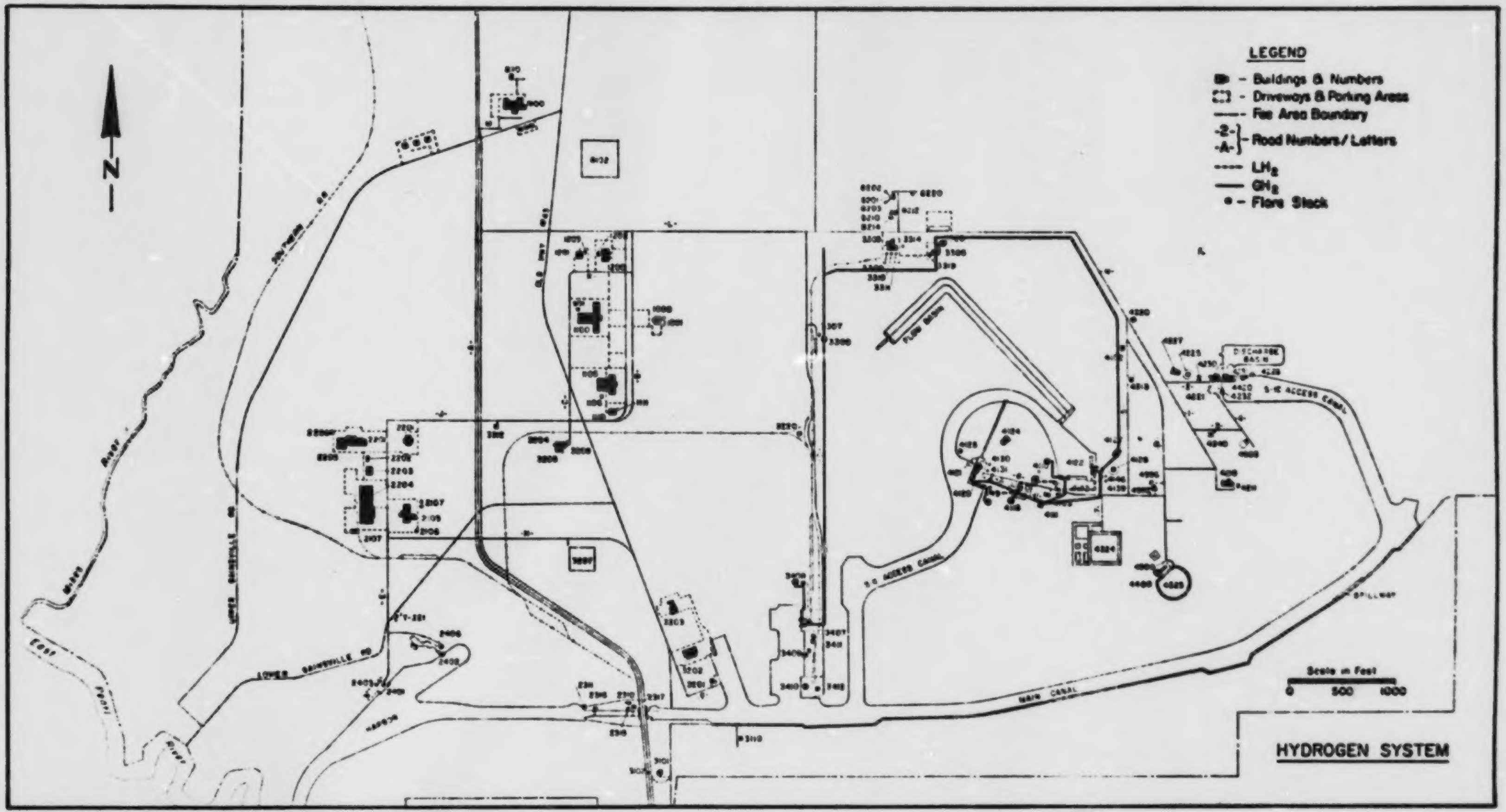


Figure 58



Modified from The MTF Master Plan (1971) and Stogner (1973)

LOCATION OF UTILITIES SYSTEMS IN THE MTF SOUTHERN FEE AREA

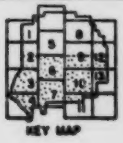
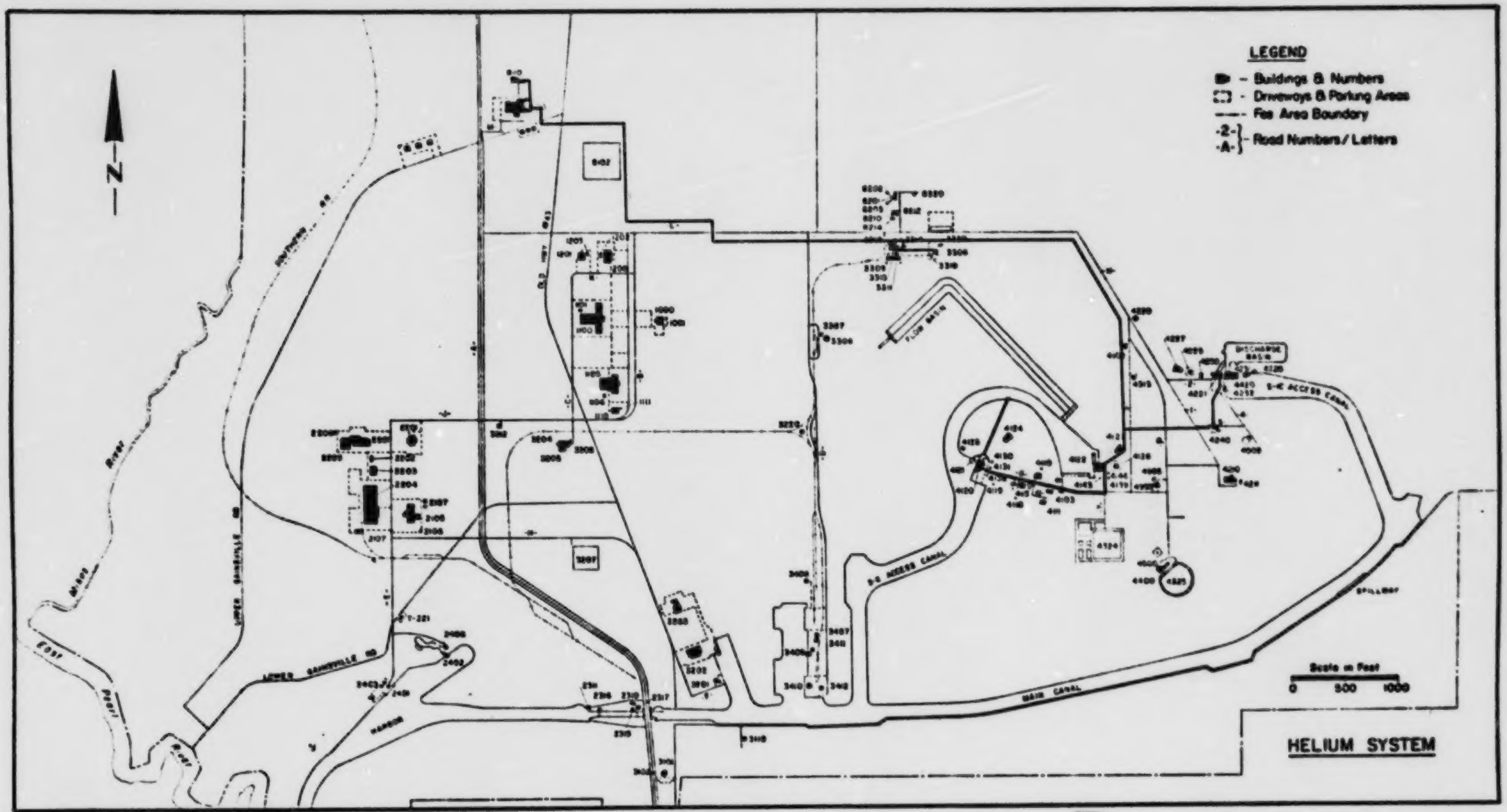


Figure 59

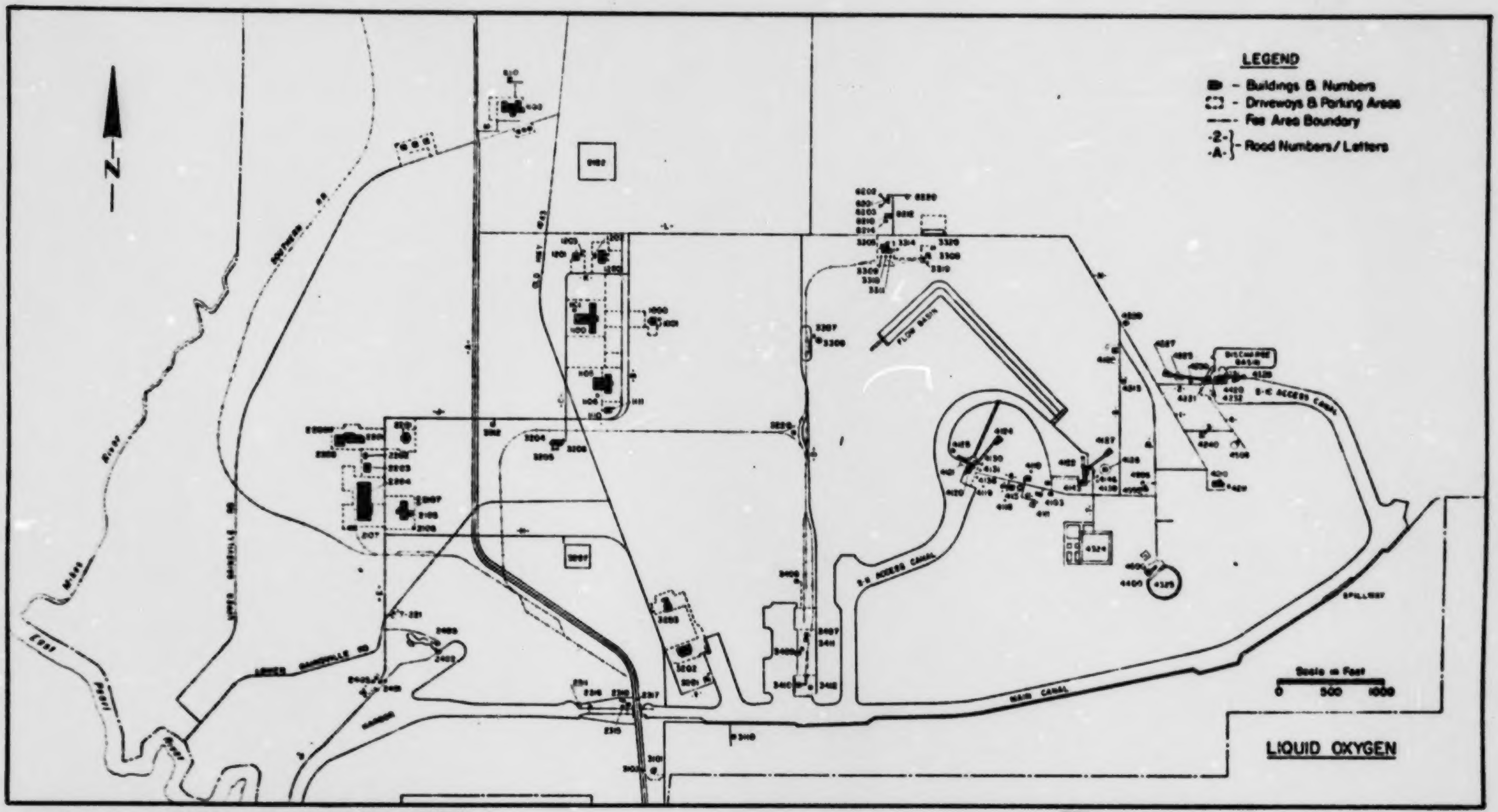


Modified from The MTF Master Plan (1971) and Stegner (1973)

LOCATION OF UTILITIES SYSTEMS IN THE MTF SOUTHERN FEE AREA

KEY MAP

Figure 60



Modified from The MTF Master Plan (1971) and Stagner (1973)

LOCATION OF UTILITIES SYSTEMS IN THE MTF SOUTHERN FEE AREA

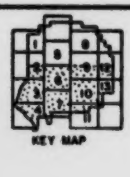
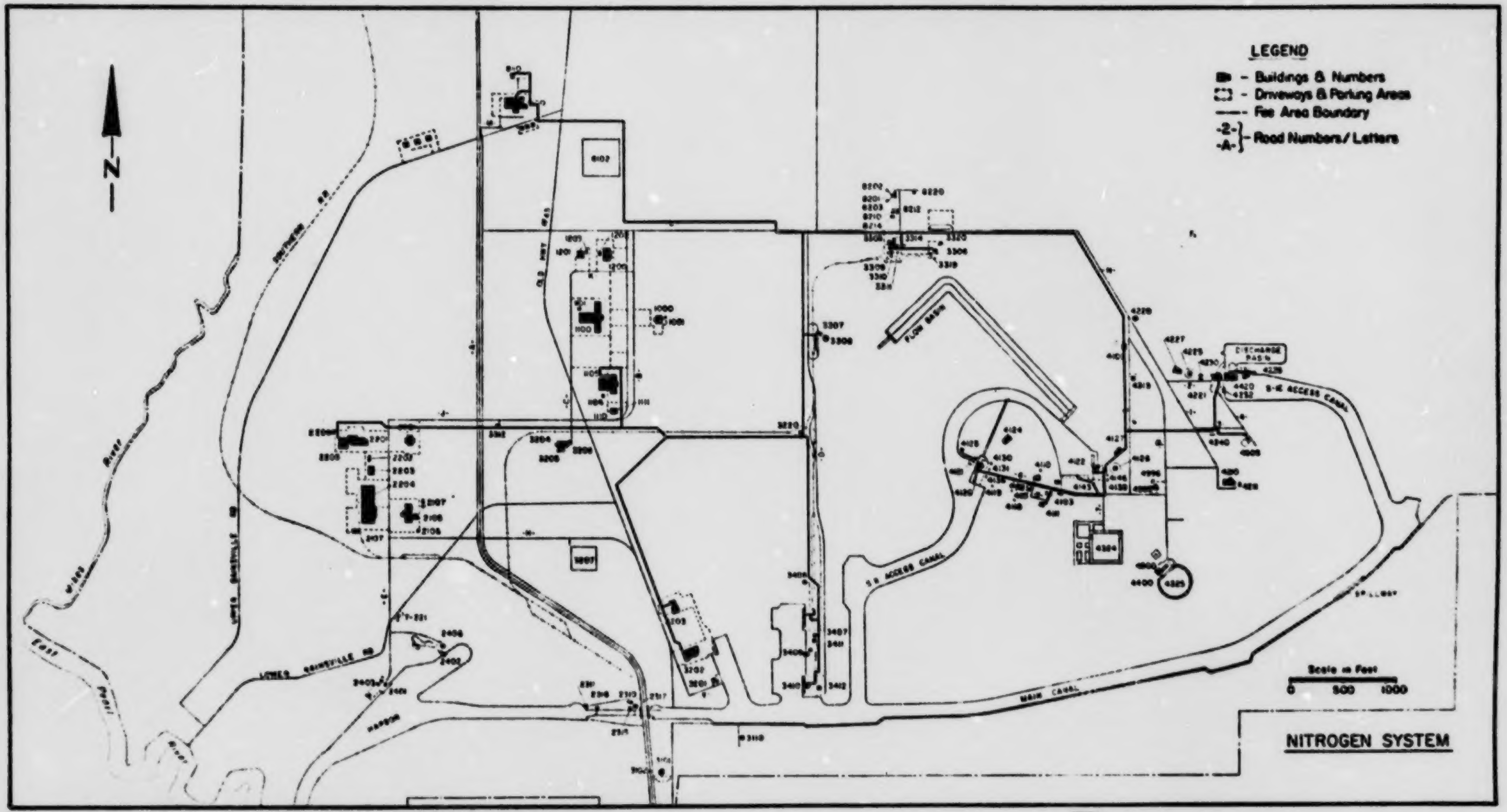


Figure 61



Modified from The MTF Master Plan (1971) and Stegner (1973)

LOCATION OF UTILITIES SYSTEMS IN THE MTF SOUTHERN FEE AREA

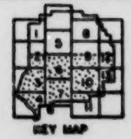
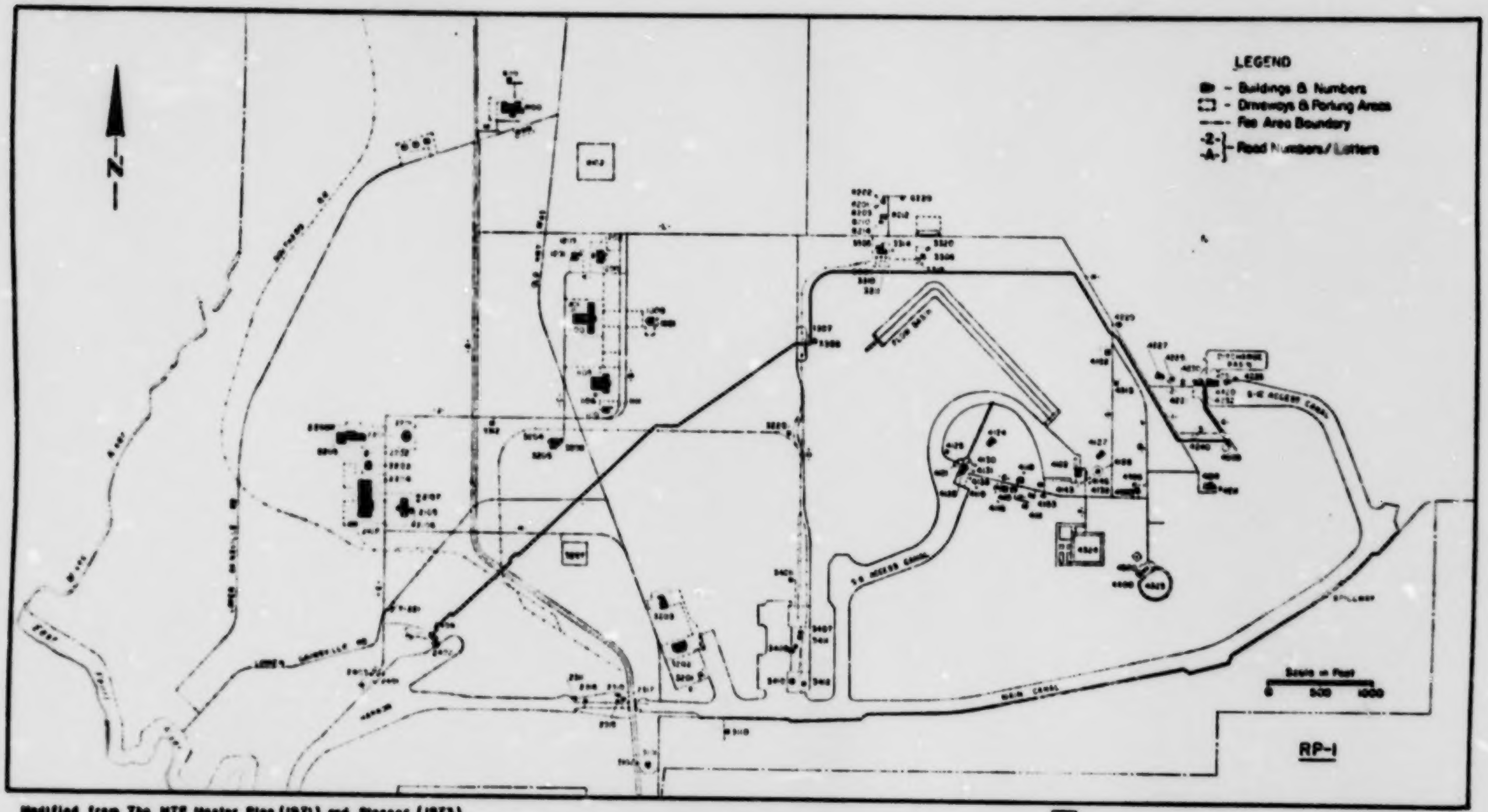


Figure 62



Modified from The MTF Master Plan (1971) and Stegner (1973)

LOCATION OF UTILITIES SYSTEMS IN THE MTF SOUTHERN FEE AREA

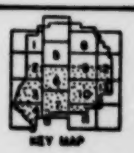


Figure 63

These utility systems were designed specifically for the NASA rocket testing program and were engineered and constructed to be amenable for future expansion. It should be remembered that the greatest concentrations of utility developments at MTF are presently located within the southern Fee Area (see baseline map--Figure 51). Sources of information for this description include the 1971 MTF Master Plan, updated engineering data from Global, and various on-site interviews.

## Potable Water System

Typical abbreviations used in this report are: psi, pounds per square inch; psig, pounds per square inch gauge; scf, standard cubic feet; scfm, standard cubic feet per minute; S-IC, first stage of Saturn V vehicle; S-II, second stage of Saturn V vehicle; RP-1, rocket propellant no. 1; gpm, gallons per minute; TDH, total discharge head; Hz, hertz; and kV-A, kilovolt-amperes.

The Fee Area potable water system was designed to furnish an average of 40 gallons per person per shift (based on design population figures) as well as a capacity at peak levels 2.5 times the average. The system includes:

a) Three 1600-ft. deep wells that supply water at 30-40 psig.

b) Two elevated holding tanks with 300,000 gallons capacity each (used to maintain an average pressure between 65-70 psig).

c) A system of 3-way hydrants in the Building and Storage Area for fire protection (one hydrant per 100,000 sq. ft. of open storage area).

d) Gate controls to section-off various lines for construction or maintenance.

e) Various pumps, chlorinators, and automatic rectifiers in the two storage tanks.

The system is capable of serving 1.5 times the ultimate building manpower requirements for MTF. Notable features of the system include:

a) A fire flow capacity of 1500 gpm for 4 hours at 20 psi minimum residual pressure.

b) Corrosion control for elevated storage tanks (cathodes powered by rectifiers located in the base of the tanks).

c) Automatic refill controls for the elevated tanks.

d) Chlorinators that work in conjunction with the booster pumps for filling the elevated tanks.

In addition, regular samples are taken for on-site water quality monitoring of the system (for chloride concentration and various contaminant levels). The records of the water quality monitoring of the system indicate compliance with State and local requirements. Also, the fire hydrant locations at MTF meet the specifications of the National Board of Fire Underwriters.

## High Pressure Industrial Water System (HPIW)

The industrial water system (HPIW) at MTF is confined to the southern Fee Area, and was designed to: 1) cool test stand flame deflectors, 2) protect propellant barges at the three test stands, and 3) protect the test stand structures (fire deluge protection). Fire protection was also provided to the S-IC, RP-1 Ready Storage Tank. The system consists of:

a) Three wells (capacity 13,500 gpm).

b) Ten diesel-driven pumps (33,385 gpm capacity each, individual discharge head of 495 ft.).

c) Two electric power-driven pumps (200 gpm and 3000 gpm with 495 ft. TDH).

d) A 66-million-gallon reservoir (800 ft. diameter).

e) The HPIW Emergency Power Generating and Heating Plant Complex.

The system also includes a 75-inch diameter line to the S-II complex and a 96-inch diameter line to the S-IC complex. In the S-II area, the HPIW offers a deflection flow of 168,000 gpm and a full deluge flow of 72,500 gpm. In the S-IC complex, the deflection flow is 300,000 gpm and the full deluge flow is 123,000 gpm.

The HPIW system at the MTF has the capacity to offer an excellent supply of good quality water at peak demands, and could be expanded either with additional wells or trunk lines (depending on NASA's future testing needs).

## Sanitary Sewerage Systems

Three separate systems service the southern Fee Area, each collection system terminating into a sewage lagoon. The systems collect, treat and dispose of sewage from the major buildings and structures in the Fee Area. Each system has an average capacity of 30 gallons per capita per 8 hour shift, with a maximum capacity of 2.5 times the average. The treatment is secondary and consists of anaerobic and aerobic bacterial digestion, and dilution (with monitoring to determine adequate levels of dilution before discharge into the Pearl River system). The system was designed based on a surface loading of 30 pounds of 5-day BOD (Biochemical Oxygen Demand) per acre per day, with a discharge of adequate DO (dissolved oxygen) that will not interfere with normal aquatic biota in the river.

There is, at present, some controversy concerning the effectiveness of the system. Laboratory chemicals, oils, and other wastes enter the system in varying amounts and may not be adequately treated before discharge into the Pearl River. The Mississippi State University Research Center filters its chemical wastes in an oyster shell percolation bed before discharge.

In addition to the above systems, eight septic tanks service outlying buildings in the southern Fee Area, and two package plants (north and south Reception Centers) operate independently. There is some question concerning the effects these units have on local groundwater quality nearby (especially during peak flows).

## High Temperature Hot Water/Chilled Water Systems

Within the southern Fee Area, two High Temperature Hot Water Systems (HTHW) were designed to service the S-IC and S-II test complexes, the engineering, stage and propellant, maintenance, and other support areas. The Test Complex System originates in the HPIW Emergency Power Generating and Heating Plant Complex, and distributes HTHW to the test stand complexes through four miles of 6- to 8-inch diameter insulated lines which are protected in underground conduits (main stem lines were designed for 25 per cent expansion). The Test Complex System (HTHW) offers water at 400° F. to the S-IC complex (maximum head 700 ft.; capacity 360,000 gpm), and to the S-II complex (maximum head 700 ft.; capacity 212,000 gpm). The return water is 250°F. (closed system). The Test Complex System (HTHW) consists of the following equipment:

a) Three 15-million Btu per hour hot water out-put generators,

b) Primary and secondary circulating pumps.

c) Expansion tanks.

d) A water treatment system.

e) A nitrogen pressurizing system.

f) A combustion control system.

g) A natural gas and fuel oil (no. 2) system.

The test complex system is heated by natural gas; however, no. 2 diesel oil may be substituted if necessary.

The Support Area Heating Plant contains similar equipment and furnishes water to 6 miles of 1.5 to 10 inch diameter insulated lines which are protected in underground conduits (main stem lines designed for 25 per cent expansion). The Support Area Heating Plant has three output generators, each with a capacity of 40 million Btu per hour.

In addition to the above, two chilled water systems are located in the test areas. One system connects the S-II Test Control Center with the S-II Test Stands (A-1 and A-2). The second system connects the S-IC Test Control Center with the S-IC Dual Test Stand Structure.

## Electrical Distribution System

The MTF is serviced by two 110-kV overhead transmission lines by the Mississippi Power Company. These lines connect to the Site Main Power Station, located to the south of the canal area and to the east of the bascule bridge. The Main Power Station is comprised of a primary switch yard ( operated by the Mississippi Power Co.) and a main substation (operated by the MTF Support Contractor--Global).

The Main Power Station feeds into the Fee Area Electrical Distribution System, which is comprised of both overhead and underground power lines. Although the system has provided adequate power to date, alternate power is available either from the Louisiana Power and Light Company or from the Mississippi Power Company. In addition, an on-site power back-up system exists and is a self-contained generating plant that is capable of providing three-phase 60 Hz electrical power up to a maximum of 7500 kV-A. This self-contained unit includes the following:

a) Four 2120 horsepower, 12 cylinder diesel engines with direct couple to a series of

b) 1875 kV-A revolving-field generators.

These engine-generator sets with auxiliary apparatus form a precise power unit that is capable of a continuous power production with frequency regulation of ± 0.02 Hz.

## Natural Gas System

Served by the United Gas Pipeline Company; the MTF gas supply is distributed throughout the Fee Area via 8 miles of 6-, 8-, and 10-inch diameter pipeline and 2 miles of 1-inch diameter pipeline. The United Gas Pipeline Company's mainline runs east-west 0.75 miles north of the Fee Area and is equipped with a pressure reducing and metering system. Natural gas is supplied from this point at 100 psig.

Anodes (consisting of magnesium metal with 10-ft. long leadwires) were installed to protect all pipelines from corrosion at the site. As the natural gas enters the site, it passes through an odorizing station (Bldg. 6002) where a liquid odorant is added to the gas to give warning of gas leaks. The principal uses of natural gas at the site include:

a) Fueling the Central Heating Plant (3204).

b) Fueling the Saturn Test Area Heating Plant (4400).

c) Fueling the Meteorological Building (8201).

d) Fueling the Compressor Building (3305).

e) Use in the S-II Test Stand flare stacks.

f) Use in the Hydrogen Gas Shelter.

g) Use in the Stage and Propellant Storage Area.

h) Use in the laboratories in the Engineering and Administration Building (1100), and in the Electronics, Instrumentation, and Materials Building (1105).

Another use of natural gas has been the fueling of the GSA (General Services Administration) automobile fleet in order to curb automotive emissions at the site. At the Central Heating Plant (3204), a compressor rated at 150 scfm and 8500 psig, and a storage trailer rated at 100,000 scfm and 6000 psig service the vehicles at 2250 psig.

High Pressure Air System

Filtered air is distributed throughout the site (S-II and S-IC Test Complexes, the Engineering Area, the Stage and Propellant Storage Area, and the Maintenance Area). The system includes:

a) Two identical reciprocating compressors with a capacity of 850 scfm each, and a discharge pressure of 3500 psig (one used to supply normal demand with the other on standby).

b) Purifiers of the absorption type with fully-automatic reactivation and capacity of 1700 scfm (which conditions the high pressure air to a minimum dewpoint of -65°F and a maximum hydrocarbon content of 15 ppm by volume).

c) Oil bath filters used when air is first drawn into the compressors.

d) Intercoolers and cooling tower systems to stabilize the compressor operating temperatures.

e) Automatic controls which provide protection to the compressors from pressure, temperature, and vibration.

f) Coolers and scrubbers, ahead of the purifiers, to remove most of the oil from the air.

g) Filters after the purifiers which remove the rest of the excesses of oil in the high pressure air.

Maximum usage of the system (as of 1971) was 1,900,000 scf during a 24-hour period, or an average of 79,200 scfh. Each site facility has its own storage tanks, all of which are designed for a maximum working pressure of 3750 psig. To date, the system has been adequate for the needs of the site (operating on one compressor except during peak periods immediately following a test, when the second compressor would make up the difference).

## Hydrogen System

### Liquid Hydrogen

The MTF Hydrogen System is designed to handle both liquid ($LH_2$) and gaseous ($GH_2$) states. $LH_2$ was principally used as a fuel for S-II stage propulsion and thus the primary facilities are concentrated there. Briefly, a survey of facilities and capacities associated with the $LH_2$ Distribution System includes:

a) Flexible connections for $LH_2$ transfer, disposal, control and instrumentation.

b) Transfer stations accommodating 3 trucks and 2 railcars in the railcar and tank truck area.

c) Equipment for remote monitoring and control of $LH_2$ transfer, flare stack ignition control, small tool storage, and office space in the Liquid Hydrogen Control Bldg. (4136).

d) The Flare Stack System which includes a distribution system and accessories for routing hydrogen to the stack for normal boiloff during tanking procedures (mounted tanks provide pilot fuel and acetylene for stack ignition and flame detection)--air for pilot ignition is available from a pressure-controlled system.

e) A warning system and control circuits which are activated by a Hydrogen Gas Detection System.

f) A Hydrogen Fire Detection System providing the capacity for detection of fire throughout the $LH_2$ transfer and barge area.

g) A hydrogen and nitrogen provision for purging, drying, and instrumentation control by the High Pressure Gas System.

h) A Water Deluge System providing fire protection at connecting points in the transfer system.

i) An $LH_2$ Barge System ($LH_2$ Storage and Transfer Area) consisting of:

    1) Storage and transfer capacity of 240,000 gal. (usable volume) per barge (3 barges), with unloading and loading at the rate of 5000 gpm.

    2) A nitrogen pressure-controlled system at 750 psig which supplies control gas for operations of all barge-mounted valves.

    3) A Water Deluge System providing fire protection for the $LH_2$ barges and accessories.

    4) An Interfacing for land-based systems, such as main $LH_2$ fill, hydrogen vent, control and instrumentation, electric power, ground connection, gaseous nitrogen, and deluge water.

j) Docking facilities at each S-II test stand for two $LH_2$ barges with the Distribution System necessary for transfer to the vehicle tank interface and for defueling the storage tank--each test facility provides the following:

    1) A main fill line with capacity for transfer from two barges at 10,000 gpm of $LH_2$ to the test vehicle interface.

    2) An $LH_2$ catch tank with a 150,000 gal. capacity for emergency defueling of either test stand.

    3) A flare stack, to vent and burn $GH_2$, at each barge dock and the $LH_2$ catch tank.

    4) An 8000 gpm HPIW system providing fire protection to the barge dock area.

## Gaseous Hydrogen

This complex system provides and distributes $GH_2$ at 4500 psig to the S-II Test Complex. It includes $LH_2$ storage and vaporization equipment and a Distribution System to convey filtered $GH_2$ to the S-II Complex and to the $LH_2$ transfer area. In brief, the system includes the following:

a) $LH_2$ from the $LH_2$ barges is transferred via railcar or trailer truck to the High Pressure Gas Facility (3306) and transferred to storage in a 50,000 gallon tank.

b) From here, the $GH_2$ is generated by two pump vaporizer units (one unit with a capacity of 1250 scfm at 6000 psig for normal operations; the other with a capacity of 5680 scfm was converted to nitrogen service, but may be reconverted to $GH_2$ service if needed) and transferred to the S-II Test Complex and the Cyrogenic Propellant Transfer Area.

c) The $GH_2$ piping is designed to transmit 2900 scfm of $GH_2$ to the S-II Complex at a maximum of 6300 psig at -20°F. (Vented gas is discharged through safety valves in the lines which are manifolded into the hydrogen disposal system and piped to a flare stack).

d) Gaseous nitrogen ($GN_2$) and helium (GHe) are provided for purging the hydrogen lines ($LH_2$ and $GH_2$) and high pressure pumps.

e) All $LH_2$ lines, except the lines between pumps and vaporizers, are vacuum jacketed.

f) $GH_2$ stored at the S-II Complex is contained in a high-pressure storage battery consisting of 1250 and 1375 cubic ft. tanks (usable storage capacity of 642,000 scf operated between 2200-4500 psig).

g) From these storage batteries, the $GH_2$ pressure is reduced to 750 psig at the High Pressure Gas Facility (HPGF) for purging in the Cryogenic Propellant Transfer areas.

In the above systems, the total liquid storage ($LH_2$) capacity is 50,000 gallons, the tank boil-off and pump operating losses amount to 304 gallons/hr. (over a 48 hr. period these losses amount to 14,600 gallons), and the total usable liquid remaining (after losses) has an equivalent gas ($GH_2$) volume of $2.88 \times 10^6$ scf.

## Helium System

The MTF gaseous helium system (GHe) operates at a normal pressure of 6300 psig and distributes GHe via the Integrated Distribution

System to the S-II and S-IC Complexes, to service areas for tests, and to other areas to sustain various operational uses. Common uses for GHe include:

a) The servicing of test vehicles.

b) The minimizing of stratification of LOX (liquid oxygen) in vehicle tanks.

c) The pressurizing of on-board propellants.

d) Component analyses and instrument tests and calibrations.

The distribution and facilities involved in the GHe system include the following:

a) A High Pressure Gas facility which receives the GHe from railcar or tube bank trailer, and

   1) Distributes it to 2 low-pressure storage spheres (capacity of 350,000 scf each, 550 psig), and

   2) Into the compressors (three 200 scfm, 6300 psig units manifolded together), and then to

   3) A cold box, charcoal-type purifier rated at 400 scfm, 6300 psig (to clean hydrocarbon and moisture contaminants from compressor discharge), and on to

   4) Cartridge-type molecular sieve units provided for back-up purification (10 $\mu$ [micron] nominal size--used also at various locations throughout the system for particulate control) and finally into the

b) Distribution System which consists of the following:

   1) Relief valves (low-pressure storage as well as on the 6 compressor units), automatic interlocks, cut-outs, etc. for safety.

   2) A flow-meter and gas purity analyzer on the compressed gas discharge line.

   3) 4 high-pressure (6300 psig) storage containers (3 containers at the S-II Complex, each with a capacity of 1500 cubic ft. of water volume and 1 container at the S-IC Complex with a capacity of 1065 cubic ft. of water volume).

4) 3 compressors (6300 psig) which regulate pressure in the system (two are used normally with the third employed during stage-testing operations).

5) The option of a direct railcar tapping into the Distribution System to maintain a pressure of 3800 psig (with the residual railcar load to be emptied into the high pressure storage containers via compressors).

The GHe Integrated Distribution System is also supplemented with trailer-truck recharge stations throughout the site for facilities directly and not directly served. Such recharge stations include the S-IC Booster Storage Building, the S-II Storage and Checkout Building, the Engineering, Instrumentation and Materials Building, and others. In addition, expansion of the MTF GHe system can be made by addition of compressor, purifier and/or storage units.

## Liquid Oxygen System

The MTF Oxygen System is centered in the southern Fee Area and is capable of providing storage and transfer of large quantitites of LOX (liquid oxygen). The LOX is used as the oxidizer in the S-IC and S-II stages. The system includes the following facilities and capabilities:

a) LOX, delivered by barge, railcar or tank truck, is received at the transfer area of the Test Complex utilizing:

   1) Two barge-mounted pumps (capacity of 1000 gpm each) to transfer the LOX either directly through the transfer system into the stage LOX storage tank (the landbased storage tank has a capacity of 460,000 gallons) or directly to the barges at an average of 1600 gpm and 20 psig.

   2) Five 200 gpm pumps to unload trailer trucks and tank cars (one pump at each of the five transfer stations immediately north of the main LOX storage tank).

b) The above items are contained in the Storage and Transfer Facility located at the Cryogenic Propellant Dock, or at either S-IC or S-II Test Complex LOX Dock and Transfer Facilities (the transfer area has the facilities for docking six barges--each with 95,000 gallons total volume, a 2500 gpm pump for stage tank tapping, and a 2250 psig $GN_2$ (gaseous nitrogen) system with pressure reducing station to provide 750 psig $GN_2$ for locally controlled valve operation).

In addition to these facilities, the S-II and S-IC Complexes contain the following:

a) Flexible hose connections at vehicle filling and topping manifolds at dockside.

b) Flanged connections on the test stands.

c) In the S-II Complex, docking facilities for two barges and shore-to-barge connectors; in the S-IC Complex, docking facilities for five barges and shore-to-barge connectors.

d) A main fill line for LOX transfer with 20 $\mu$ [micron] filters (S-II is 10 inches diameter for 5000 gpm, and S-IC is 14 inches diameter for 10,000 gpm).

e) An LOX dump line for emergency (S-II is 12 inches diameter; S-IC is 18 inches in diameter).

f) A topping line connecting the topping pump from barge to stand (S-II is 3 inches diameter for 250 gpm pump, S-IC is 4 inches diameter for 500 gpm pump).

g) A system to provide water to the barge deluge systems (S-II is 2500 gpm; S-IC is 10,500 gpm).

Five barges are normally used for the S-IC LOX requirements (total capacity of 475,000 gallons) with a sixth used for a back-up. The barges and storage systems have been adequate in the past tests and could be used for $LH_2$ (temperatures are designed to be compatible) transport.

## Nitrogen System

The MTF Nitrogen System is designed to generate gaseous nitrogen ($GN_2$) from liquid nitrogen ($LN_2$). $LN_2$ is received at the High Pressure Gas Facility (HPGF) either by tank trailer or railcar and is transferred by pumps through filters to liquid storage tanks. $LN_2$ is retrieved from the storage tanks with three centrifugal booster pumps which transfer the liquid to seven high-pressure pumps (each with a hot water heat exchanger or vaporizer that converts the liquid to gas ($GN_2$) at 6300 psig at ambient temperature).

From here, the $GN_2$ enters the Distribution System which is equipped with a 50 gpm pump vaporizer unit (with accessories this unit increases the site nitrogen-pumping by approximately 50 per cent). In addition, a bypass around the $LN_2$ storage tanks is provided in order to shunt the $LN_2$ directly into the $GN_2$ conversion process. Typical uses for $GN_2$ at the site include:

a) Various missile-quality uses at the S-IC and S-II Complexes.

b) Environmental testing and control, maintaining an inert atmosphere, purging, and pressurizing propellant tanks, lines, power control valves, and instruments .

c) Distribution to the Propellant Dock Area for purging, operation of valve controls, and fire suppression.

Approximately three percent of the total site consumption of $LN_2$ is diverted to the Electronics, Instrumentation and Materials Laboratory (1105) and to the Component Services Shop (2205) for various stage tanking sites and test purposes. In addition to the above, the Component Test Facility (8100) has an independent $LN_2$ system for cryogenic testing.

## RP-1 System

The RP-1 (Rocket Propellant-1) fuel system at the MTF is designed to receive, store, filter, and transfer large quantities of RP-1, the fuel used in the S-IC stage propulsion system. RP-1 is delivered to the site via railcar or tank truck and transferred into a 650,000 gallon storage tank in the Central Storage Area. Barge delivery is possible at the RP-1 Transfer Dock with transfer via the underground distribution system to the Central Storage Area. RP-1 is then transferred via underground piping from the Central Storage Area to a 300,000 gallon ready storage tank in the S-IC Test Complex. Typical elements of the RP-1 system include the following:

a) Two 600 gpm pumps at the RP-1 Transfer Dock which pump the fuel from the barge to the Central Storage Area .

b) Four railcar or truck unloading stations at the 650,000 gallon tank, each equipped with a 200 gpm pump for transfer into the storage vessel.

c) Two 625 gpm pumps for transfer of the fuel from the Central Storage Area to the ready storage tank at the S-IC Complex.

d) A $GN_2$ system that reduces pressure from 750 to 1 psig for purging purposes.

e) A deluge water system at the storage tank in case of fire and for temperature control .

f) A 300,000 gallon ready storage tank with:

  1) Two 1000 gpm pumps for transfer of the fuel to the stage fuel tank .

2) Reduced $GN_2$ pressure for operating valves and controls and for storage tank purging.

3) Two truck unloading connections, each with 250 gpm pumps for transfer of the fuel to ready storage.

4) A 3950-gallon capacity burn-off pit for disposal of RP-1 from relief valves and filters.

5) A 20 inch diameter emergency defueling line to return fuel from the stage to the storage tank (capacity of 14,000 gpm)--entire time needed to defuel a stage is 15 minutes.

6) A temperature control system to maintain a fuel temperature at 30° - 90°F.

Again, the twelve utilities systems described above provide excellent services to the MTF Fee Area. A HMSE program at the MTF should be designed to take advantage of these systems, which in many individual cases are not only unusual for any given location, but are also ideal in terms of systems concentration and coordination.

## Telecommunications at the MTF

In addition to the twelve utilities previously described, a series of telecommunications systems service the site and include the following:

a) A No. 5 Crossbar Centrex Communications Unit located in the Telephone Building (1201) providing 1500 service lines (operated by the South Central Bell Telephone and Telegraph Co.).

b) A government-owned and Global operated cable and wire system installed in the hazardous test areas with interface between the two systems in Bldg. 1200 (telegraphic and facsimile service is available in Bldg. 1201 with cryptographic service available for classified transmission).

c) An area-wide DOD call contract lease and maintenance arrangement for the MTF radio communications (servicing needs of transportation, supply, security, and acoustics with a Collins 500 Single Sideband Transceiver used on an as-required basis).

d) An oral-warning system with capabilities of both oral and aural transmission (separately or simultaneously) servicing the entire MTF Fee Area.

e) In addition to the cryptographic equipment for transmission and receipt of teletype messages, in accordance with National Security Regulations, a 28 ASR 60-word-per-minute Western Union teletype machine connects the site to the State and Interstate systems and a Magnafax network (100-words-per-minute) are available.

f) An operational Intercom System providing two-way voice communications within each test complex and support area (19 channel system linked to a main console with trunk lines extending throughout the site) which is backed up with a second-powered phone system in case of a power failure.

## Other Services at the MTF

Services provided by utilities are often interrelated with various personnel services. The MTF offers various personnel services, a few of which are described below:

a) Fire Protection--two 500 gpm pumpers, one 750 gpm pumper, one 750 gpm pumper and dry chemical unit, one HD-6 tractor and plough (forest fires), one 1000-gallon portable water tank, one well-equipped rescue truck, and two auxiliary trucks with booster tanks are available in addition to the fire-hydrant and deluge systems for the MTF Fee and Buffer Zones' protection. The staff for these activities is well-trained, and reciprocating agreements have been made with surrounding communities and various forestry industries for support aid.

b) Security--two reception centers (north and south) provide guard-supervised access to the MTF Fee Area on a 24-hr./day basis. Identification badges, telecommunications equipment, monitored or patrolled perimeter roads, fencing, and classification of security materials are some of the techniques and equipment employed in the operation. Each tenant or agency is responsible for its own identification badges, classification, and personnel security.

c) Medical Services--emergency and non-emergency services are available to government personnel with all site personnel provided with emergency ambulance services and other associated activities.

d) Pollution Control Services--involve the utilization of the sewerage systems, various holding ponds, and treatment units for chemical wastes, and the shipment of toxic or voluminous materials off-site to a processor. Air quality control has been attempted with various burn-off valves on the gaseous distribution and storage systems, and the utilization of natural gas powered GSA automobiles, as noted earlier. Refuse burning is also controlled at a minimum. Sound levels exceeding 90 decibels are the object of feasible administration or engineering controls when discovered on site.

e) Emergency Support Plans--at the MTF include plans to cope with various emergencies, such as fire and explosion, power failure, disaster recovery, severe weather, hurricane conditions, civil defense, fall-out shelters, serious accidents, and civil disturbances. These various plans are controlled and instituted by various agencies when the needs arise; e.g., Fire Department personnel, the MTF Emergency Director, etc.

f) Control Planning and Engineering of Liquid Propellants--at the MTF was designed based on the potential explosive nature of these hazardous substances. Table 20 is the Quantity-Distance Requirements Table given in the 1971 MTF Master Plan (p. 77). (This chart is reproduced in this text for convenience, as well as for the later conclusions formulated from baseline information.) By column, the chart describes the following:

   1) Building or facility number where the substance is stored.

   2) The MTF designated name of storage area .

   3) The symbol of the propellant substance used.

   4) The quantity of the substance, or storage capacity of the location in pounds.

   5) The quantity of the substance in gallons or its liquid equivalent .

   6) The TNT equivalency in pounds or its designation by class of explosive potential as follows:

      (a) Group I (GP-I)--a limited fire potential and should be separated by some distance from inhabited buildings.

      (b) Group II (GP-II)--exhibits properties such as vigorous oxidation or rapid combustion when exposed to organic matter which is difficult to exclude; the potential result is spontaneous combustion and a destructive fire .

      (c) Group III (GP-III)--materials that are subject to the hazards of fragmentation

## TABLE 20

## MTF -- QUANTITY-DISTANCE REQUIREMENTS[1,2]

| Bldg. Number | Designation | Matl. Used | Quantity in Lbs. | Quantity in Gals. | TNT Equiv. | Inhabited Bldg. Q-D |
|---|---|---|---|---|---|---|
| 3306 | $GH_2$ Compressor<br>1 Storage Tank | $LH_2$ | 29,600 | 50,000 | GP-III | 1200 ft. |
| 3307 | RP-1 Storage | RP-1 | 4,700,000 | 650,000 | GP-I | 275 ft. |
| 3403 | LOX Storage Area (6 Barges) | LOX | 5,400,000 | 570,000 | GP-II | 570 ft. |
| 3403 | LOX Storage Tank | LOX | 4,200,000 | 440,000 | GP-III | 555 ft. |
| 3405 | $LH_2$ Storage Area (3 Barges) | $LH_2$ | 425,000 | 720,000 | GP-III | 1800 ft. |
| 4120 | S-II Stage<br>A-1 Stand | LOX<br>$LH_2$ | 858,000 | 74,000<br>260,000 | 515,000 lbs. | 5600 ft. |
| 4120 | A-1 Stand<br>2 LOX Barges | LOX | 200,000 | 210,000 | GP-II | 320 ft. |
| 4120 | A-1 Stand<br>2 $LH_2$ Barges | $LH_2$ | 284,000 | 480,000 | GP-III | 1800 ft. |
| 4122 | A-2 Stand<br>2 LOX Barges | LOX | 200,000 | 210,000 | GP-II | 320 ft. |
| 4122 | A-2 Stand<br>2 $LH_2$ Barges | $LH_2$ | 284,000 | 480,000 | GP-III | 1800 ft. |
| 4122 | S-II Stage<br>A-2 Stand | LOX<br>$LH_2$ | 858,000 | 74,000<br>260,000 | 515,000 lbs. | 5600 ft. |
| 4220 | S-IC Stage<br>S-IC Stand | LOX<br>RP-1 | 4,540,000 | 336,000<br>200,000 | 454,000 lbs. | 5200 ft. |
| 4220 | S-IC Stand<br>5 LOX Barges | LOX | 4,500,000 | 475,000 | GP-II | 555 ft. |
| 4220 | S-IC Stand<br>Storage Tank | RP-1 | 1,700,000 | 250,000 | GP-I | 235 ft. |
| 4400 | HPIW | RP-1 | 680,000 | 100,000 | GP-I | 190 ft. |

TABLE 20 CONT'D.

| Bldg. Number | Designation | Matl. Used | Quantity in Lbs. | Quantity in Gals. | TNT Equiv. | Inhabited Bldg. Q-D |
|---|---|---|---|---|---|---|
| 8100 | Component Service Facility Dewar (Mobile) | $LH_2$ | 156 | 1000 L. (264 gal.) | GP-III | 600 ft. |
| 8100 | Facility Dewar (Mobile) (2) 175 Litre Dewars Installed | $LH_2$ | 55 | 350 L. (92 gal.) | GP-III | 600 ft. |

---

[1] From the 1971 MTF Master Plan (p. 77).

[2] Common abbreviations used in this report are as follows: $GH_2$, gaseous hydrogen; $LH_2$, liquid hydrogen; RP-1, rocket propellant-1; LOX, liquid oxygen; and HPIW, High Pressure Industrial Water System.

and deflagration; the potential hazard involves pressure rupture of the storage container and consequent deflagration and vapor phase explosion.

7) The inhabited building's Q-D, or quantity distance in feet, as the distance that should be placed between a propellant storage facility (or test stand) and the nearest inhabited building.

g) Other Support Services and Analytical Laboratory Facilities-- at the MTF are interlocked in an integrated system based on multi-use or interdisciplinary design. Typical services include local, regional and national weather reports from the meteorological building personnel; photography services (color, infrared, ultraviolet, remote, etc.) from the photo lab facilities, EROS and ERL; national and international data buoy information from the Data Buoy System; local, state and national geohydrologic information from the USGS; various pesticide determinations and water quality analyses from the EPA labs; acoustical determinations with the on-site acoustical facilities; photoduplicative and data retrieval from the Global Data Center; plus a wide assortment of informational sources associated with the various personnel and library resources at the MTF. Typical aspects of these facilities are the analytical nature as well as the flexibility of design. Typical investigative areas include gases, water, soil, organic tissues, fuels, solvents, cryogenics, metals, polymers, and other organic and inorganic compounds. At present, the MTF laboratories are involved variously with pesticide chemistry, marine biology, chemical and physical oceanography, air pollution and meteorologic measurement, water quality analysis, macro- and micro-biologic studies, aquatic community studies, and others.

Supporting these analytical facilities are the engineering instrumentation, photo-optical instrumentation, operation instrumentation, and measurement instrumentation units at the MTF. Briefly, the investigative and instrumentation devices and expertise available at the MTF include:

1) Thermo analyzers .
2) Bomb colorimeters .
3) Colorimeters.
4) Atomic absorption .
5) Metallographs.
6) Ultrasonics .
7) Gross physical testers .
8) Gas and thin-layer chromatography .

9) Micro-organism culture, treatment, and evaluation.
10) Mass infrared and ultraviolet spectrophotometers.
11) Remote sensing devices.
12) Instrumentation, optics, video and control circuitry.
13) Photographic-photo-optical equipment and repair.
14) Electronic calibration, repair, and maintenance.
15) Acoustics calibration and maintenance.
16) Closed circuit TV support and maintenance.
17) Instrumentation development and fabrication.
18) Meteorologic sensing, calibration, repair and maintenance.
19) Environmental testing such as reverberation analyses, noise analysis, sound-induced mechanical energy analysis, noise propagation studies, etc.
20) Various measurement instrumentation services such as physical and electrical standards, pressure calibration, testing and evaluation, instrument cleaning, calibration, etc.
21) Oceanographic sensing including analyses of conductivity, temperature, depth, sound velocity, current direction and speed, and salinity.
22) Environmental chambers providing controlled temperature, humidity, salt spray, sun, radiation, shock, and vibration.
23) Various test support services such as a wide range of engineering, fabrication, modification, calibration, etc.

In addition, various agencies and tenants at the MTF are conducting on-going research programs which continually provide need for laboratory modification and expansion. A significant feature of the MTF is the USGS hydraulic flow basin and floodplain development near the western edge of the Test Complex Area. Other facilities include various ponds, ditches, a mini-river (with a larger model projected in the future), and acres of forest, marsh and bayou.

## Computer and Data Handling Facilities

The MTF computer and data handling functions, including computer processing, storage, and data distribution, are largely provided by the National Aeronautics and Space Administration's Slidell Computer Complex (SCC) located approximately 20 miles northwest of the MTF at Slidell, Louisiana. The Slidell Computer Complex represents a government investment of more than $21 million in equipment and $5 million in the physical plant. The facility is capable of providing the following functions:

a) Development of the necessary pre-computer processing techniques to reformat and digitize the data to produce a computer-compatible tape for rapid automatic reduction of large volumes of data.

b) Design and implementation of numerical methods and computer programs for processing of data; verification of programs with simulated and actual data; and production processing of business computer systems. The results may be delivered in the form of magnetic tapes, printed listings, automatic plots, or reports.

c) Production of final data packages of the highest accuracy with minimum time lapse from receipt of raw data.

d) Provision of programmer consultation for users developing their own software packages.

e) Provision of "quicklook" data in a minimum time after completion of a test with an evaluation of these data to advise the customer of any serious malfunction or deficiency that should be corrected before proceeding with the next test in the series.

f) Performance of any further data analysis and computation deemed necessary that would yield additional data to assist the customer in the final system performance analysis.

g) Provision to the customer of the complete test data management function to assure continuity of flow between test planning and final system performance analysis.

Digital computation support is provided by four main computer hardware systems and a wide assortment of computer software. The primary computer system is the UNIVAC 1108 Multiprocessor. A UNIVAC 1108 Unit Processor also is supported, as are two IBM 7094's.

The primary Executive systems and programming languages currently utilized on each computer are:

| LANGUAGES | EXECUTIVE SYSTEMS |
|---|---|
| UNIVAC 1108 Multiprocessor | |
| FORTRAN V<br>COBOL<br>APT | EXEC VIII |

## UNIVAC 1108 Unit Processor

| | |
|---|---|
| FORTRAN V | EXEC II |
| COBOL | EXEC VIII |

## IBM 7094 Unit Processor

| | |
|---|---|
| FORTRAN IV with IBLIB | IBSYS/IBJOB |
| COBOL | |
| SORT | |
| APT | |
| AUTOCODER (IBM 1401) | |
| SPS (IBM 1401) | |

The UNIVAC 1108 Multiprocessor contains three central processors and two input/output controllers (3x2). Each of the processors can perform all functions required for the execution of instructions including arithmetic, logical, input/output, and executive control. The peripheral equipment consists of 24 tape units each with a maximum transfer rate of 96,000 characters per second; five printers each with a printing rate of 1200 lines per minute; and two card punches and readers with speeds of 300 and 900 cards per minute, respectively. The main storage of the Multiprocessor is a 256K thirty-six bit word magnetic core; however, magnetic drums comprise the auxiliary storage that provides over 273 million words of storage. The communications subsystem connects a variety of remote terminals to the computer. Present terminals consist of Remote Demonad, Remote Batch, and CRT Communications Terminals.

The UNIVAC 1108 Unit Processor is a general purpose computer used for both scientific and business applications. The central processor executes instructions including arithmetic, logical, input/output, and executive control. The peripheral equipment consists of 12 tape units, each with a maximum transfer rate of 96,000 characters per second; three printers, each with a printing rate of 700 lines per minute; and one card punch and reader with speeds of 300 and 900 cards per minute, respectively. Main storage of the 1108 Unit Processor is a 131K thirty-six bit word magnetic core. Auxiliary storage consists of 11 magnetic drums providing over 44 million words of storage.

The two IBM 7094 Unit Processors are each capable of supporting large scale scientific and business type applications. These systems operate independently, with an IBM 1401 providing the necessary preprocessing or reformatting. The IMB 7094 peripheral equipment consists of 12 tape units for the IBM 7094-24 and 16 tape units for the IBM 7094-20. Maximum transfer rate is 90,000 characters per second. One card reader, with a speed of 250 cards per minute, is also with each IBM 7094. Main storage for each 7094 is a 32K thirty-six bit word magnetic core. IBM 1401 Computer Support is provided to the two IBM 7094 computers by an IBM 1401 computer with an 8000-character core. The 1401 provides card-to-tape, tape-to-print, and tape-to-card operation in its support function.

The following summary provides an overview of the SCC available software for the major computer systems at the Slidell Computer Complex. Vendor manuals and local documentation are available for the detailed information required to utilize the software systems.

1) FORTRAN V LANGUAGE PROCESSOR

FORTRAN V (FORmula TRANslation) is an outgrowth of earlier FORTRAN and is compatible with those languages. It is an algebraic language designed for scientific and engineering computations.

2) COBOL LANGUAGE PROCESSOR

COBOL is also a problem-oriented language. It is a "stylized English" language defining a set of rules and procedures designed primarily for business applications.

3) SORT/MERGE UTILITY LIBRARY

The SORT/MERGE package is a fully modular, self-contained functional unit that allows the programmer to adapt the independent modules for his specific needs by presenting parameter values on control statements at load time.

4) PLOTTING SOFTWARE UTILITY LIBRARY

The S-C 4020 PLOT package contains a collection of routines written in FORTRAN to allow the user to present data in graphic and tabular form for plotting on the S-C 4020 Microfilm Plotter. The EAI 3500 Flat Bed Plotter plot package is an SCC version of Electronic Associates Incorporated standard plot software.

5) MATHEMATICAL FUNCTION PROGRAM

The mathematics library includes a collection of basic mathematical functions and subroutines that are available to each of the programming languages.

6) MATHEMATICAL PACKAGE

The MATH-PACK provides a comprehensive library of 78 fundamental mathematical subprograms of the more frequently used methods of numerical analysis.

## 7) STATISTICAL PACKAGE

The STAT-PACK provides a comprehensive library of 90 fundamental statistical subprograms of the more frequently used methods of statistical analysis.

# APPENDIX B

## MTF TENANT AGENCIES, PROGRAMS, FACILITY USAGE AND POTENTIAL AVAILABILITY

### INTRODUCTION

The Mississippi Test Facility has research and development-oriented tenants in residence that are conducting programs of both national and regional importance which could substantially contribute to a HMSE (Hazardous Materials Spills Equipment) testing program. The tenant agencies represent several Federal and State agencies, as well as universities, that are evolving programs and projects aimed at understanding, controlling and alleviating growing environmental issues. The following includes information pertinent to the MTF tenant agency capabilities and programs, primary facility usage, and potential availability for incorporation in a HMSE testing program. Agencies presently in residence at the MTF and which have a potential for contributing to a Hazardous Materials Spills Equipment test/demonstration program include:

National Aeronautics and Space Administration

1. Earth Resources Laboratory/NASA
2. Space Shuttle Main Engine Office/NASA
3. Mississippi Test Facility/NASA

Department of Interior (U.S. Geological Survey)

1. Earth Resources Observations Systems (EROS)
2. Gulf Coast Hydroscience Center
3. National Park Service/Ecological Services Laboratory

Environmental Protection Agency

1. Water Quality Field Laboratory
2. National Pesticide Monitoring Laboratory
3. Pesticide Chemical Regulation Laboratory

Department of Commerce

1. National Marine Fisheries Service/Fisheries Engineering Laboratory
2. National Data Buoy Center/National Ocean Survey
3. National Oceanographic Instrumentation Center/Gulf Coast Region
4. Environmental Field Experiment Engineering Center/Office for Monitoring and Prediction
5. National Weather Service/Lower Mississippi River Forecast Center

Department of Defense

1. U.S. Army Munitions Command

Universities Marine Center

Gulf Universities Research Corporation

Universities

1. Mississippi State University
2. Jackson State College

## TENANT AGENCY PROGRAMS, FACILITY USAGE AND POTENTIAL AVAILABILITY

This section describes the current tenant agency programs, facility usage and potential availability for incorporation into a program for testing equipment to control Hazardous Materials Spills. On-going programs and facility usage and potential availability have been edited to highlight items that would be most useful in the development and support of an HMSE Facility.

### National Aeronautics and Space Administration: Summary of Primary Facility Usage and Potential Availability

NASA has overall management responsibility for the MTF and is currently the largest user of the site facilities. Facilities that would be of interest for possible inclusion in a HMSE program include: three test stands equipped with 75,000 gallon-per-minute deluge systems and concrete-lined drainage channels; a high-pressure water facility equipped with ten diesel pumps capable of delivering 320,000 gallons per minute; a 55 million gallon industrial water reservoir; a liquid oxygen, hydrogen, helium, nitrogen, RP-1 (Kerosene) and other liquid fuel storage and handling systems; a 7-1/2 mile man-made canal system; a 670' long and 110' wide canal lock; a support service complex including maintenance, motor pool and warehouse facilities; 13 miles of operating railways and 35 miles of highways and roads; laboratory facilities;

a data handling center connected to the Slidell computer complex; and engineering and administration buildings and personnel.

The space shuttle program is expected to utilize most of the test stand facilities during the next few years. It is unlikely that the rocket test stand structures, concrete-lined drainage channels, and the canal system would be available for incorporation into a HMSE facility, although the high pressure water system is being used only part of the time and would probably have a high availability for inclusion in an HMSE program. The remaining facilities and services appear to be operating at only partial capacity at this time. Projected usage of these facilities is somewhat uncertain and will depend heavily upon the success of future NASA program funding. Office space and partial use of existing facilities are expected to remain available for at least another year.

## NASA: Current Program Elements

The Earth Resources Laboratory (ERL) complements and supplements Earth Resources activities being conducted at the Goddard Space Flight and Manned Spacecraft Centers. Its primary emphasis is in the development of remote sensing techniques for practical applications. The development of the techniques involves the use of data generated by Earth Resources aircraft, Earth Resources technology satellites and the Skylab Earth Resources experiment package. Experimental remotely sensed data will be compared and correlated with a wide variety of surface measurements obtained at local test areas. The experimental investigations being undertaken at ERL will be conducted primarily in the South Central and Gulf area and will be keyed to interests and needs in this general area.

The Space Shuttle Main Engine Office program will involve the static testing of the shuttle main engine hardware for research and development purposes as well as flight worthiness.

The NASA-MTF is responsible for all site functions of technical and institutional support services. They provide a base for shuttle main engine testing, engage in applications engineering in association with other government activities at the MTF, and engage in environmental information research activities in association with state and local public bodies.

## Department of Interior (U.S. Geological Survey): Summary of Primary Facility Usage and Estimated Availability

The Gulf Coast Hydroscience Center operations offer a substantial potential for supporting an HMSE test and evaluation program. An outdoor grassed channel, designated as the Floodplain Simulation Facility, is located near the rocket engine test area.

An indoor hydraulics laboratory, designated as the Hydroscience Laboratory Facility, is located in Building 2204. The two facilities are described below (see also USGS, undated).

## USGS: Floodplain Simulation Facility

The Floodplain Simulation Facility was constructed to research the factors affecting the mechanics of flow in a channel of water, such as:

* The mechanics of flow over the flood plain to provide data on the natural undeveloped condition.
* The effect of unsteady flows on the space-time distribution of water on the flood plain.
* The effect of encroachments on the passage of water.
* The transport of waterborne materials.

The test facility is comprised of a simulated floodplain with low water channel. The floodplain is 300 feet wide, 3 feet deep and approximately 4,500 feet long. The low water channel is trapezoidal-shaped; 10 feet wide at the bottom, 1 foot deep, 2:1 side slopes and about 4,500 feet long. A plan view of the facility is shown in Figure 64.

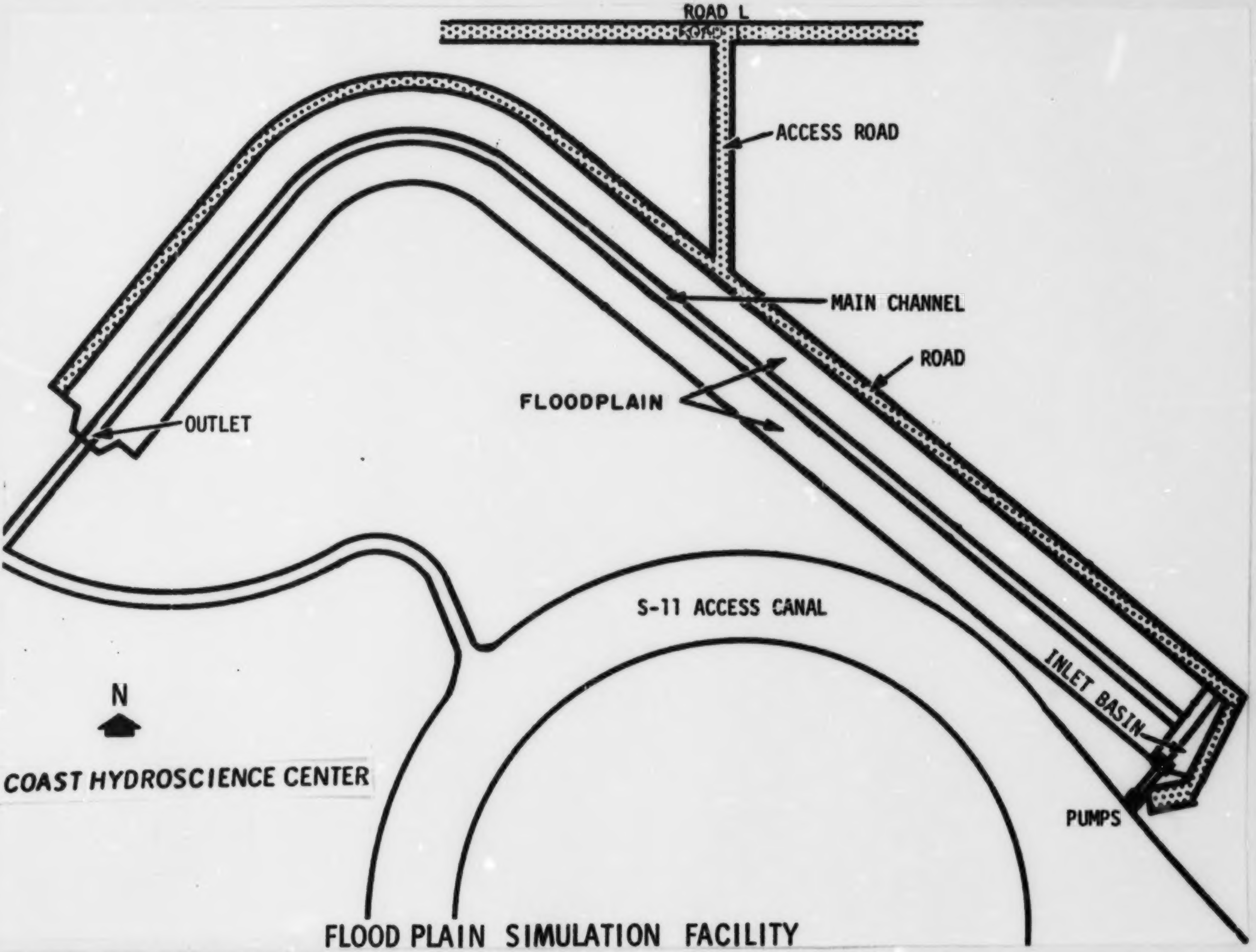
Pumping capacity is available to deliver 225 cfs, by three 75 cfs units, to the head box of the floodplain simulation facility. The total discharge can be bypassed through two 36-inch lines. A gate valve with a programmable operator is provided to bypass portions of the total flow in a known time sequence.

The total influent discharge is measured with orifices in the pump discharge line. The two 36-inch gate valves are calibrated to measure the bypassed discharge. The difference between the two measurements is the inflow to the flume.

The total outflow from the floodplain facility can be measured with a 25 foot Parshall Flume or a wier plate installed on the end of the sill in the tailbox.

A headbox is provided to distribute the flow from the pumps to the test channel. A series of hand-operated gates allow the experimenters to vary the flow distribution.

The data acquisition equipment includes depth sensors at 220 locations throughout the reach of the channel. The test information can be recorded in digital form on magnetic tape in a central location adjacent to the channel.



FLOOD PLAIN SIMULATION FACILITY

Modified from USGS (undated)

FIGURE 64

During the review of site facilities, it was noted that the flood plain simulation facility was being only partially utilized. The facility has the potential, with modification, of being adapted into a full-scale testing apparatus for evaluating stream cleaning equipment and HMSE collection devices in a flowing water environment.

## USGS: Hydroscience Laboratory Facility

The Hydroscience Laboratory Facility is used by the USGS to test and calibrate hydrologic instruments used in water resources investigations and to obtain experimental data used in research studies on the mechanics of flow and the transport and dispersion of heat, solvents and solids in rivers and estuaries. The facility's configuration is shown in Figure 65.

The calibration facilities in the laboratory include a towing tank and submerged jet tank used to test and calibrate instruments. These instruments measure water velocity by the principle of cup rotation, drag, doppler effect, acoustic signal, electromagnetic field, deflection or other means. Tests of instrumentation are performed in conjunction with research and development work on instruments conducted by the USGS Instrument Development Laboratory at the MTF. Calibration of standard instruments is an essential service provided by the USGS for its 45 district offices and for other Federal and State agencies.

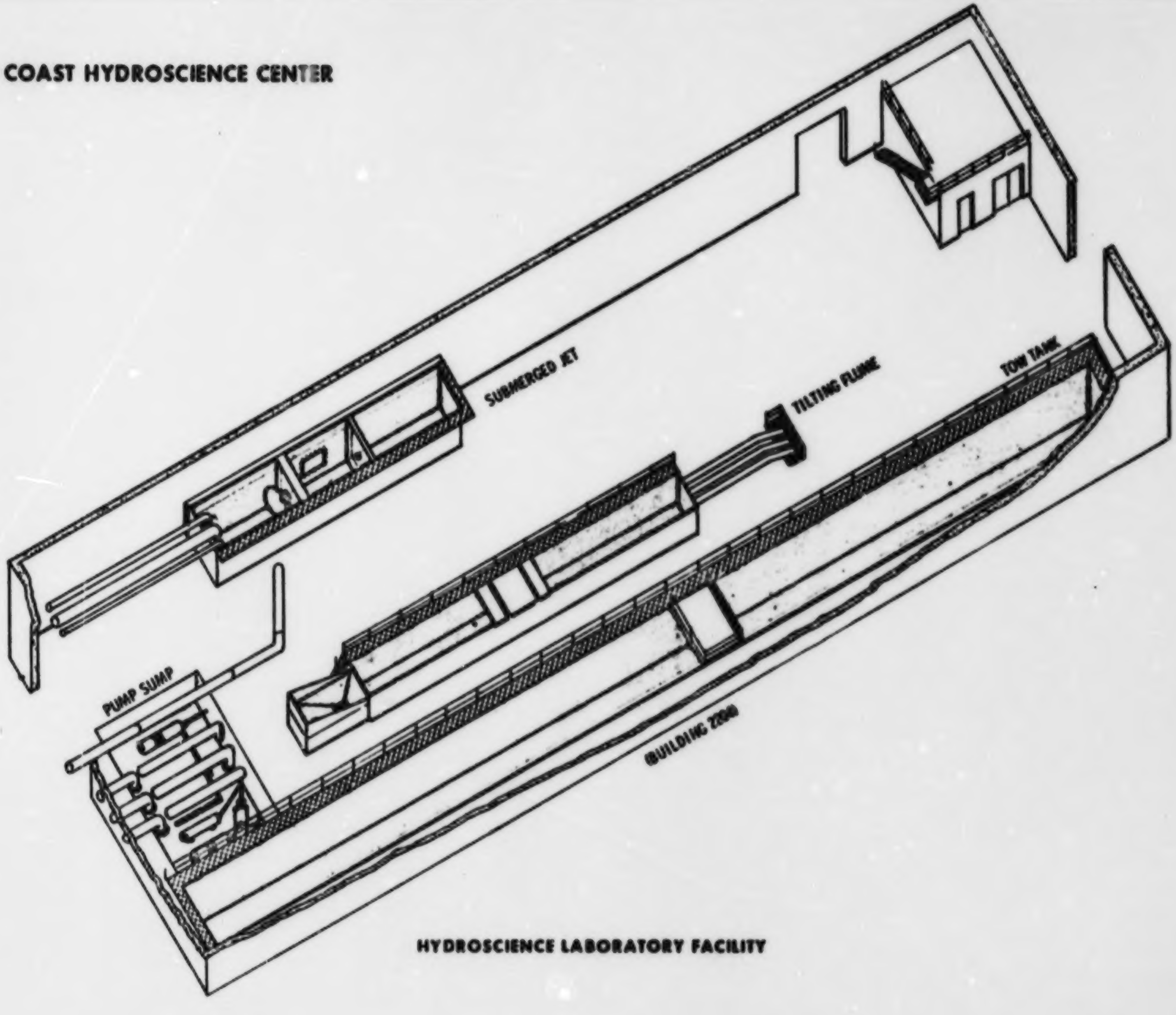
The towing tank has the dimensions of 12 feet by 12 feet by 450 feet. The tow vehicle is capable of speeds from 0 to 15 feet per second, and has a platform size of 12 feet by 14 feet. The carriage is equipped with a data acquisition system designed to accept distance traveled, elapsed time and meter pulse count information.

The submerged jet tank has a 12 foot by 12 foot cross-section and is 120 feet long. The submerged jet facility is a low turbulence-high velocity source; i.e., the water moves past the stationary meter. The discharge into the tank flows from the constant head tank to the head box of the jet, through the jet, over a wier and back to the sump from which pumps convey the water back to the constant head tank. This system allows for a stable discharge varying less than 0.5 percent. Discharge measurements can be made with an orifice plate, sharp crested wier, and a volumetric tank.

The tilting flume is used to obtain experimental data on model-scale which is used with theoretical considerations to:

- Develop digital models for evaluating the effects of man's encroachment on the flood plain.

# GULF COAST HYDROSCIENCE CENTER



HYDROSCIENCE LABORATORY FACILITY

Modified from USGS (undated)

FIGURE 65

- Develop models for predicting the concentration, dispersion and ultimate fate of waste injected into streams and estuaries.

- Develop models of flow systems in rivers and estuaries that are basic to the appraisal of chemical and biological systems that exist naturally or that are changed by man's activities.

- Test instruments and sampling equipment for which information is required on the effect of water depth, water velocity, or sediment concentration on instrument performance.

The tilting flume is 6 feet wide, 3 feet deep and 250 feet long. The discharge capacity is at least 50 cfs partially or wholly supplied by the constant head tank. The whole discharge can be recirculated; hence it is adequate for sediment work. The head box is 6 feet by 3 feet by 30 feet long with a function of straightening the flow prior to introduction to the flume. The type of straighteners may be varied to suit the study. The tail box is 10 feet by 8 feet by 30 feet. In a recirculatory mode, the tail box can serve as the primary storage for the water used in the flume. Additional storage is provided in an adjacent floor sump.

Three pumps are provided to service the tilting flume. There are two possible flow loops for use in connection with this facility. Clean water can be recirculated from the tail box to the constant head tank. Water then flows from the constant head tank to the flume head box in one, two or all three lines (16", 18" or 24") provided. In addition, the flume can be operated in a closed recirculating mode.

Additional facilities include an 8 inch by 40 foot closed recirculating flume. Planned activities include a wind-water tunnel to be used to study wind-generated waves, to test instruments to measure wave heights, to develop relations for the effect of wind on reservation and other stream variables.

The hydroscience laboratory facility has capability of providing large-scale testing under fully controlled conditions:

- Test capability for evaluation of monitoring and sensing systems.

- Test capability for evaluation of HMSE spill response equipment in a flowing water environment.

- Test capability for spill clean-up equipment in a flowing water environment.

- Pathway analysis of hazardous materials in flowing water.

The facility was not in operation during the MTF site review. It should be viewed as having a high potential for available use. The hydroscience and flood plain facilities will be analyzed in more detail in Appendix C.

## USGS: Current Program Elements

The Earth Resources Observations Systems (EROS) was established in 1966 to gather and use data of natural and man-made features on the Earth's surface collected by satellites and aircraft. The purpose of the program is to apply the improved capability to study remotely sensed natural resources, and the broad-scale, frequently repeated, regional coverage provided by Earth-orbiting satellites, to the development of a more effective resource information system.

To date, program effort has been associated with analysis of data collected by aircraft and by Gemini and Apollo spacecraft. Effort has been focused specifically on: 1) developing the ability to interpret remotely sensed data and 2) defining the sensitivity, accuracy and precision of data collected at various altitudes. Some of the specific uses of data thus far shown to be feasible are: mapping of major tectonic features, definition of hydrologic features, determination of the condition of rangeland, mapping of land use for urban planning purposes, and updating of small-scale maps.

The Gulf Coast Hydroscience Center is engaged in the development of a bathymetric profiler for acquiring data about the geometrical configuration of the floor in bays, estuaries and streams. This data will be used in the development of hydrological, mathematical or physical models of a body of water. The effects of effluents on the ecosystem of the area under consideration can then be studied, predicted and controlled. Other activities also include the development of math models of groundwater aquifers and surface water drainage basins to predict the effects of natural and man-made conditions on water resources utilizing the hydrologic labs and computer facilities at the MTF and Slidell computer annex.

The National Park Service Laboratory facility is utilized for biological analysis and research support services for the agency's operational activities in the southwest and southeast regions of the United States. Programs being serviced include enhancement of botanical attractiveness and disease detection analysis. In addition, it will perform ecological systems research aimed at developing math models for specific parks, as a tool for predicting the consequences of man-induced stress on the environment.

## Environmental Protection Agency: Summary of Primary Facility Usage and Estimated Availability

The EPA operates three laboratories at the MTF which have the combined equipment and staff capabilities of gas chromatography, atomic absorption, spectroscopy and complete wet chemical analysis. The National Pesticide Monitoring Laboratory has the technical capability of determining trace amounts of toxic materials in soils and water. Although the EPA offices, laboratories and personnel are currently being substantially utilized, some of these capabilities could be incorporated during "slow schedule" periods into an HMSE program.

## EPA: Current Program Elements

The Water Quality Field Laboratory provides chemical and biological analytical capability in the lower Mississippi River Basin region. The laboratory is used to analyze water, bottom sediment, waste treatment plant outflow, and other samples to determine type and quantity of pollutants including metals, bacteria and chemicals. This activity will relate to, and be enhanced by, other MTF environmental acitivities such as the remote sensing of the NASA Earth Resources laboratory, USGS hydrological activities, the MTF scientific laboratories, the EPA pesticide laboratories and the Environmental Instrumentation Center of NASA/MTF.

The EPA National Pesticide Monitoring Laboratory provides analysis of nationwide samples to determine trace amounts of pesticides and other pollutants in soils, various crops, and non-target wildlife.

The Pesticide Chemical Regulation Laboratory at the MTF is a regional chemical analytical laboratory for analyzing manufacturer's commercial pesticides and other chemical products for conformance with Federal regulations, such as labelling.

## Department of Commerce: Summary of Primary Facility Usage and Potential Availability

The Department of Commerce facility usage at present is primarily office space. Some shop space, photo service, dockside space and data processing capabilities are represented and could be partially used by an HMSE program.

The data buoys being developed by the National Data Buoy Center (NDBC) offer the potential for providing a base for monitoring ocean environments. Currently, the oceanographic data buoys are capable of monitoring ocean currents and temperatures.

## DOC: Current Program Elements

The National Marine Fisheries Services/Fisheries Engineering Laboratory located its Remote Sensing Program in the MTF environmental center in September of 1970. Activities in the program are the development of remote sensors, data management, and biological sample handling. Immediate effort has been directed toward the remote sensing element of the program with limited efforts in the other two areas, dealing primarily with the establishment of project criteria.

The National Data Buoy Center (NDBC) mission is the development of capability for deploying oceanographic and meteorological data buoys for research and operational needs. Presently, the NDBC has awarded contracts for supply of high capability data buoys and integrated sensor systems. Assembly, checkout, and acceptance testing of the complete buoy is performed at the MTF. In support of the NDBC, the MTF is providing office space, shop space, facility engineering services, office and shop furniture and equipment, utilities, machine shop, welding shop, portable test equipment, dockside space, mobile equipment, tugs, x-ray service, photo service, data processing, computer services, contract procurement and administration, financial administration, and other support. Similar support services could be available to an HMSE Facility.

Another MTF capability in regard to this program is the MTF launching ramp which provides access into the canal system and which is capable of handling the 160,000 pound buoys.

The National Oceanographic Instrumentation Center (NOIC) has provided planning at the MTF for the upgrading of the Environmental Instrumentation Center and will have capability to meet the initial oceanographic and meteorological systems test and calibration requirements of the NDBC, The facility will test and calibrate NDBC instrumentation sensing oceanographic parameters such as sea water, ocean current velocity and sensing meteorological parameters such as wind speed and direction, dew point, air temperature, barometric pressure, global radiation and precipitation rate.

The mission of the Environmental Field Experiment Engineering and Test Integration Center (EFTIC) is the development, test and acquisition of equipment and facilities for major national and international field research projects concerned with the oceans and atmosphere. A number of experiments have been proposed which are related to programs such as the International Decade of Ocean Exploration, International Hydrological Decade, and Global Atmospheric Research Program (GARP). These include National Field Year on the Great Lakes.

The tenant National Weather Service Office is presently engaged in preparation and issuance of river flood forecasts for the lower Mississippi River and its tributaries, using a computerized digital simulation model.

## Department of Defense: Current Program Elements

The U.S. Army Munitions Command, shortly to be renamed the U.S. Army Armaments Command, is actively conducting a pyrotechnic materials hazard evaluation program to develop and improve safety, transportation, handling and storage criteria. Recent research has been primarily concerned with explosive and chemical smoke devices. Current efforts are being directed toward the development of advanced technology for suppressive shielding of hazardous material production and supply operations. The program presently consists of three technical personnel operating with an annual budget of approximately $300,000.

The MTF Army Hazardous Materials program is considered to have substantial potential for significant contribution to an HMSE testing program at the MTF. On the basis of an extensive national site selection survey, the Army considered the MTF the best location for conducting its testing operations. Established HMSE testing and handling expertise is now maintained on a permanent basis at the site. Incorporation of this capability on a partial basis should be considered in the evaluation of an MTF-HMSE testing program.

## Universities Marine Center: Current Program Elements

The UMC function is to provide technical data and recommendations to agencies and public officials of the State of Mississippi whereby intelligent use of the State's marine resources can be accomplished, provide formal marine eduction and extensive marine advisory service, and administer the Sea Grants Program for Mississippi, Alabama, and the Central Gulf Region.

## Gulf Universities Research Corporation: Current Program Elements

GURC's formation in 1964 resulted from early recognition by a community of marine scientists of the urgent need for a multi-university regional approach to develop the educational and research capabilities concerning the Gulf marine environment at a rate commensurate with the needs of the region. GURC is an incorporated non-profit consortium of 21 universities in the five Gulf states and Mexico. From inception, GURC programs have been strongly oriented toward determining man's effects on the environment and ecology of the Gulf system and toward the intelligent and informed use of the Gulf and its resources by man. The programs include the development of a basic engineering, economic, legal, and sociological methodology to manage the Gulf system for maximum public benefit.

## Universities: Summary of Primary Facility Usage and Potential Availability

Mississippi State University - The MSU/MTF Research Center is conducting environmental and ecological research of the Central Gulf area, including the MTF, in the following areas: chemical, physical, and biological definition of the Central Gulf South Region, pollution effects determination, biological consequences of contamination of aquatic and terrestrial ecosystems, and numerical simulation models of pollution dissemination.

Jackson State College - Jackson State is presently scheduled to conduct photographic effluent disposal studies at the MTF in the Spring of 1973.

# APPENDIX C

## EVALUATION OF THE ENVIRONMENTAL BASELINE CONDITIONS, THE FACILITIES, STRUCTURES, AND THE ANALYSIS OF THREE CANDIDATE SITES FOR THE PROPOSED TESTING CENTER

### INTRODUCTION

The following unit has been organized to include evaluations concerning: 1) the baseline aspects presented previously in Appendix A, and 2) the facility-use projected-use aspects presented in Appendix B. Correlation of the baseline aspects with facility-use/projected-use aspects is presented herein, and this serves as a basis for the selection and analysis of three candidate sites at the MTF.

The evaluation techniques which have been used are arbitrary. The weighting systems used were selected based on an understanding of the range of variables observed during this study, as well as an understanding of the scope and objectives of the overall study.

Three levels of evaluative clarification were used to treat the baseline aspects. These are: 1) region and area considerations (those which delineate positive and negative parameters for the entire MTF site and vicinity), 2) general zones or subdivisions within the MTF (those which delineate positive and negative parameters important in the consideration of a general site selection), and 3) the specific site(s) within the four MTF zones (those areas which are delineated by positive and negative aspects important in the selection of the three specific candidate testing sites).

Also important in the evaluative process is the consideration of the type of testing to be considered. Whether the test element is: 1) completely closed or divorced from the ambient environment, 2) semi-closed or partially divorced from the ambient environment, 3) open or directly interrelated with the ambient environment, and/or 4) a combination of some or all of the above (open, semi-closed and closed). It is felt that the general and specific site selections are most dependent on this variation and therefore careful attention has been given to both the parameters selected and the weighting techniques used.

The general baseline parameters have been grouped into: 1) region/area aspects and 2) on-site aspects. This section treats those parameter evaluations that will be necessary in conjunction with the later evaluation of facility-use/projected-use as well as the specific site evaluations of all the MTF parameters. These factors were then formulated to serve as the basis for the recommendations and conclusions in regard to: 1) specific site location, 2) recommended alternates, 3) types of test elements most feasible, and 4) program suggestions.

## Baseline Aspects: Region and Area

Based on information assembled in the Section "Existing Facilities and Environmental Baseline Conditions," several parameters were selected as most important in the location of a facility to test/evaluate equipment to control hazardous materials spills at the MTF. These parameters are grouped into the following categories:

1. Geographic location.
2. Human resources .
3. Economic character of area.
4. Regional/subregional transportation.
5. Local/regional existing hazardous materials problems.
6. Local/regional climate.

Table 21 indicates the local/regional parameters supporting the concept of the MTF being an ideal location for establishing a HMSE (Hazardous Materials Spills Equipment) testing site. The Region and Area evaluation for developing the MTF into a national HMSE Facility is much enhanced by the physical locale of the site. The geographic, economic, climate, sociologic, and existing facilities warrant recognition as excellent resources. The present regional industrial complexes have created a need for developing an HMSE test center. while the human technologic capabilities are at hand to provide the means of solving the problems connected with handling of hazardous materials spills.

## Baseline Aspects: On-site MTF

The location and design of an HMSE Facility at the MTF was considered in relation to existing facilities, structures, utilities, and resources. A detailed treatment of the Fee and Buffer Areas was first considered, and the result was the subdivision of the MTF into four zones, primarily based on surface drainage characteristics (See Figure 66). Zone 1 basically comprises the Jourdan River tributary (Catahoula) drainage; Zone 2, the Bayou La Croix drainage; Zone 3, the Pearl River drainage area; and Zone 4, the southern Fee Area, comprises surface runoff into the Pearl System with the possibility that subsurface drainage flows to the Bayou La Croix.

## TABLE 21

## EVALUATION OF LOCAL/REGIONAL PARAMETERS IMPORTANT IN THE SELECTION OF THE MTF AS AN HMSE TEST CENTER

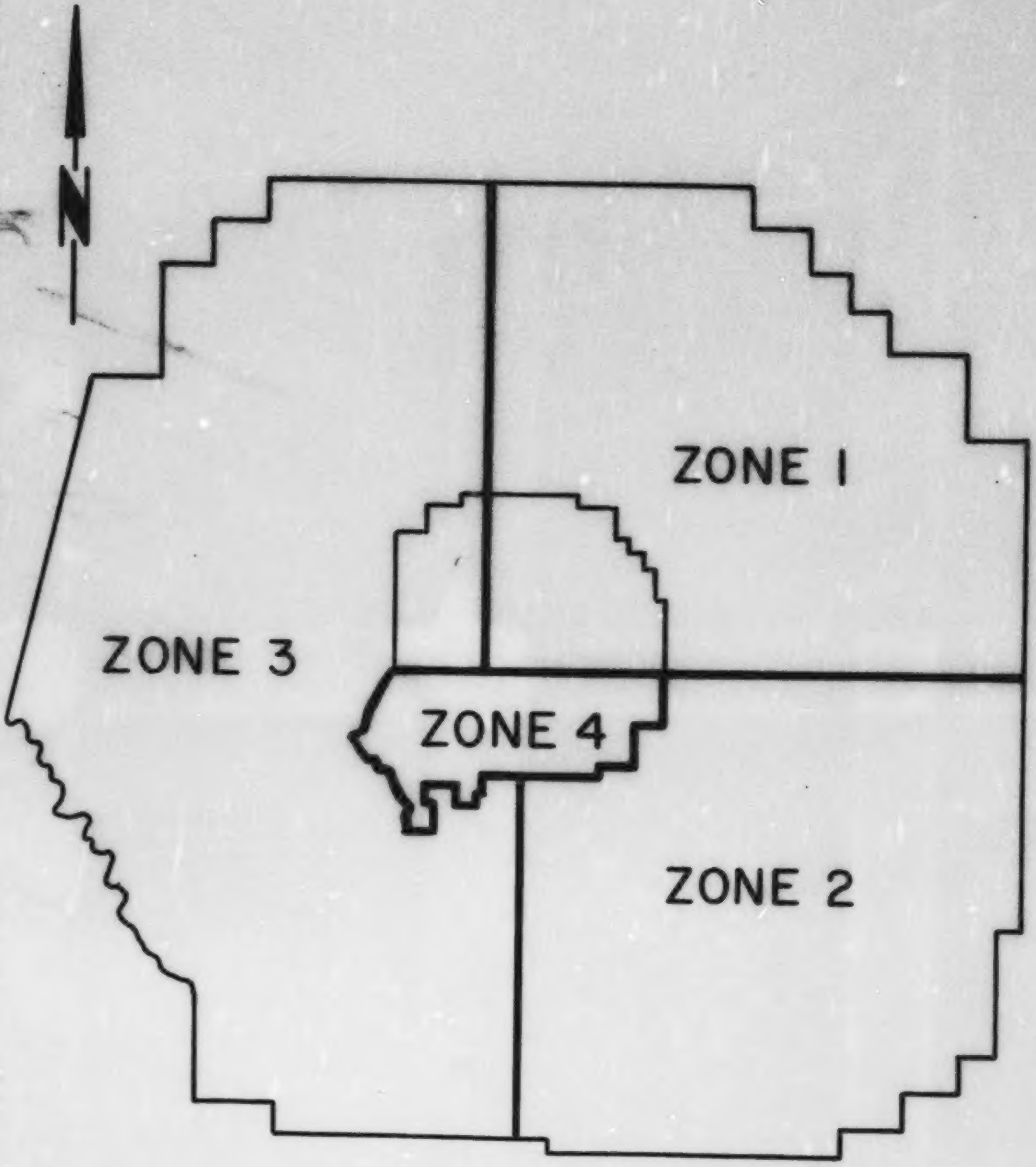
| Category | Parameter | Rating | Comments |
|---|---|---|---|
| Geographic Location | With respect to national needs. | Very good | Is a centrally located site. |
| | With respect to regional (Southeastern U.S.) needs. | Excellent | Almost a midpoint between the Gulf Coastal States. |
| | With respect to local/sub-regional needs. | Excellent | In a direct line between New Orleans and Mobile, most of the greatest population densities of the State being nearby. |
| | Degree of isolation from public. | Excellent | An already secured buffer zone area as well as low population density immediately surrounding the site. |
| Human Resources | Proximity of nearby cities (New Orleans, Mobile, Jackson, etc.). | Excellent | Expertise, training, technical resources, etc., including a wide range of industry-trained technicians. |
| | Proximity of surrounding towns in area (Picayune, Bay St. Louis, Waveland, Gulfport, etc.). | Excellent | Population of nearby communities already geared to the MTF as a focal point of employment and other socio-economic ties. |

TABLE 21 (Continued)

| Category | Parameter | Rating | Comments |
|---|---|---|---|
| Regional/ Subregional Transportation | Access via air (either through major or minor commercial, private or government-owned). | Very Good | Major airport facilities exist in the area and charter service can be made directly to Stennis Airfield at the MTF. |
| | Access via interstate, state and local highways. | Excellent | I-10 and feeder arteries are modern and designed for efficient rapid transport. |
| | Access via waterway (e.g. Mississippi River, inter- and intra-coastal waterways). | Excellent | A system of waterways directly connects all seaports, the Great Lakes, and the entire Mississippi River system to the MTF Canal System. |
| | Interfacing connections between air, ground & water transport. | Excellent | National/regional/local connections are well developed and expanding with need. The Hancock County Port south of the site will function as an additional asset. |
| Local/Regional Existing T&HM Problems | Located in midst of an area producing steel, petroleum products, various chemicals, pesticides, sulfur, pulp wastes & other commodities. | Excellent | Birmingham, Baton Rouge, Mobile, New Orleans and many towns, cities, and villages contain industries already producing and handling T&HM. |
| Local/Regional Climate | Mild winters, warm summers, evenly distributed rainfall, 150 sunny days/year, 125 partly sunny days/year, on-shore-off-shore Gulf influences. | Excellent | Very comfortable asset that attracts tourists. |
| | Catastrophic meteorological events. | Good | Degree of catastrophic meteorological event is minimal compared with other Gulf Coast communities - damage during Camille (1969) was not detrimental to long-range activities at the MTF and northward. |

TABLE 21 (Continued)

| Category | Parameter | Rating | Comments |
|---|---|---|---|
| Human Resources (Cont'd) | Availability of a wide range of skills in area. | Good | Many persons possessing multi-disciplinary technical, semi-skilled and advanced degrees already at the MTF and at nearby institutions. |
| | Availability of a wide range of potential employees. | Good | A wide range of skills available; partially as a result of close proximity to the New Orleans Metropolitan area. |
| Economic Character of Area | Southeastern U.S. growth rate in relation to entire U.S. | Excellent | Latest U.S. Dept. of Labor statistics cite the Southeast U.S. as the fastest growing part of the nation. |
| | Southwestern Mississippi in relation to current and projected growth trends. | Excellent | Sprawl from New Orleans as well as rapid growth of the Gulf Strip communities provide the base for an expanding local economy. |
| | Degree of stability of local economy. | Very Good | Local economy is dependent on a balanced industrial/agricultural/tourism/other service economy - well diversified in nature. |



SCHEMATIC VIEW OF THE MTF BUFFER ZONE & FEE AREA SUBDIVIDED INTO ZONES

Figure 66

Analyzing the MTF Fee and Buffer Areas by these zones, assists in separating many of the environmental baseline parameters into various degrees of definition and amenability to an HMSE Facility design. Thus, the multiparameter evaluation formulated from the results of the baseline studies illustrates the notable differences in the degree of definition and amenability to an HMSE Test Program. The following paragraphs will further summarize the importance of a multiparameter evaluation of parameters in each of the four zones of the MTF.

## THE MULTIPARAMETER EVALUATION OF THE MTF BY ZONE

The following represents a key to Table 22, Evaluation of Baseline Parameters at the MTF in relation to the testing of equipment to control hazardous materials spills (pp. 259 to 261). Analysis of Table 22 will show the following column headings:

> Super-Title Category -- Name referring to a topic area that most closely resembles one of the study items in Appendix A.
>
> Parameter Considered -- Selected aspects that are important enough to be considered in a semi-open or open-system hazardous materials spills equipment test program.
>
> Zones 1 Through 4 -- See Figure 66 for specific locations: Zone 1, northeast MTF area; Zone 2, southeast MTF area; Zone 3, western MTF area; and Zone 4, southern Fee Area (see Figure 66 for detail).

It is important to review Appendix A for the meaning or reason for selection of a parameter classification for a particular zone. The evaluations are based on technical information and may not be apparent to the reader unskilled in a particular discipline; e.g., hydrology or soils. Parameters selected for analysis were chosen because: (1) these items are capable of being quantified and are often regarded as "unknown" information in delicate open system test designs, and (2) in terms of a potential accidental release into the environment of a hazardous material (gas, liquid or dust) -- these parameters should be well-defined in order to predict and to clean-up the escaped material. Additionally, the definition of these parameters would make valid and more effective, the design of testing controls.

Symbols used in the evaluations of each parameter by zone are described below:

### Degree of Definition of Parameter

A. Defined or well-defined in relation to a hazardous materials spills equipment test program.

B. Incompletely defined in relation to a hazardous materials spills equipment test program .
C. Poorly defined or undefined at present.

### Adaptability to a Hazardous Materials Spills Equipment Test Program

a. Valued as most valuable to a wide range of tests.
b. Valued as moderately valuable to a hazardous materials spills equipment test program.
c. Least valuable in terms of hazardous materials spills equipment test program.

The choice of symbols (A, B, C, etc.) was arbitrary; but was intended as a means to avoid or minimize bias in the overall evaluations of each zone.

Considering the wide range of hazardous materials, as well as possible tests involving control equipment, it was impossible to be more detailed than the symbol meanings used. Again, the most minimal conditions necessary for a series of potential tests govern the suitability of the assignment of symbols; thus, we may have rated a zone as lower in value, because of a particularly sensitive test or material requirement. Definition when used here relates only to all available data at the time of report preparation. Adaptability when used here relates to: (1) conditions needed for the testing, (2) degree of change that may be impinged in the area without serious irreparable harm, and (3) suitability of site for a similar type of test at a later date (e.g., recovery).

Interpretation of the assigned symbols is quite variable, considering the various combinations of definition (A, B, C) and adaptability (a, b, c). The following guide is presented to aid the reader in the interpretation of these symbols combinations:

### Key to Symbols Combinations Used in Table

N/A--Means not applicable to a specific test in a specific zone -- this does not mean that the parameter has low value in an overall consideration of this site; e.g., regional attributes such as transportation could be rated Aa in all four zones.
Aa---Best defined and highly adaptable.
Ab---Best defined and moderately adaptable.
Ac---Best defined and least adaptable.
B*a--Moderately or poorly defined, but attributes rate it highly adaptable at present.
Bb---Moderately or poorly defined, but attributes rate it as moderately adaptable at present.
Bc---Moderately or poorly defined, but attributes rate it as least adaptable at present.

(*--All B values [definition] should be investigated in more detail before a test consideration of a site is made--also, if no symbol for adaptability is given, then although poorly defined, no estimation could be made.)

C*a--Our field observations, highly adaptable (estimated).
Cb---Our field observations, moderately adaptable (estimated).
Cc---Our field observations, least adaptable (estimated).

(*--All C values [definition] without a lower case symbol [adaptability] means we could not directly determine the adaptability of parameter by observation, alone -- an investigation should be made here as well as in all C value determinations before a test consideration of a site is made.)

As can be seen in Table 22, certain parameters are undefined or poorly defined in all four zones. Soil properties (all 9 parameters), sediments, meteorology (6 parameters) and biotic studies (8 parameters) are very poorly defined in the literature. Additionally, groundwater and surface water hydrology parameters are generally undefined for most zones. Although qualitative field observations (no testing or quantification) were easily made for soils, surface water, and biotic studies; groundwater and sediments characteristics would at minimum involve tracer studies (dyes, etc.).

Enough indicator tests were available in each zone (from the literature and personal interviews) to determine adaptability values in most cases. Again, in all cases where B and C values of definition occur, further definition was indicated. This extended definition can be found on pp. 18 to 44 in the field studies results of the specific sites analyses.

In terms of both definition and adaptability, Zone 4 (the Southern Fee Area of the MTF) is rated as highest in value. Zone 1 is second in the number of parameters rated favorably, and Zones 2 and 3 are less defined and less adaptable to a testing program (using presently available data and field observations). Without weighting one parameter more than any other, the results for definition can be summarized as:

|  | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
|---|---|---|---|---|
| A | 12 | 11 | 11 | 16 |
| B | 1 | 2 | 1 | 4 |
| C | 20 | 20 | 21 | 16 |

(Interpreted as, e.g., there are 12, 11, 11, and 16 "A" values [defined or well-defined] respectively for Zones 1, 2, 3 and 4, etc.)

In terms of adaptability, the results can be summarized as:

| | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
|---|---|---|---|---|
| a | 12 | 2 | 0 | 8 |
| b | 4 | 11 | 6 | 8 |
| c | 0 | 3 | 10 | 6 |

> (Interpreted as, e.g., there are 12, 2, 0 and 8 "a" values [most amenable to testing rating] respectively for Zones 1, 2, 3, and 4, etc.)

Thus Zone 4 is best defined, while Zone 1 is most adaptable to testing. Conversely, Zone 3 is least defined, while also being least adaptable. Again, this interpretation involves equally weighted parameters.

## TABLE 22. EVALUATION OF BASELINE PARAMETERS AT THE MTF IN RELATION TO THE TESTING OF EQUIPMENT TO CONTROL HAZARDOUS MATERIALS SPILLS

| Super-Title Category | Parameter Considered | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
|---|---|---|---|---|---|
| Region/Area | Regional-Subregional Aspects | N/A | N/A | N/A | N/A |
| Geology | Subsurface Formation | N/A | N/A | N/A | N/A |
| | Subsurface Stability (Horizontal Vector) | Ca | Cb | Cc | Aa |
| | Subsurface Stability (Vertical Vector) | Ca | Cb | Cc | Aa |
| Soils | Soil Type Definition | Ca | Cb | Cc | Ca |
| | Geochemical Properties | Cb | Cb | Bc | Cb |
| | Soils Hydraulic Conductivities | Cb | Cb | Cb | Cb |
| | Ionic Absorption | Ca | Ca | Ca | Cc |
| | Drainage Characteristics in Relation to Soil Types | Ca | Cb | Cb | Cc |
| | Erosional Properties -- Susceptibility | Cb | Cb | Cc | Cc |
| | Evaporation Rate in Relation to Soil Types | C | C | C | C |
| | Runoff Rate in Relation to Soil Types | C | C | C | C |
| | Infiltration Rate in Relation to Soil Types | C | C | C | C |
| Sediments | Rate of Deposition | Cb | Cb | Bc | Cb |
| | Percolation Rate in Relation to Soil Types | C | C | C | C |
| | Settlement/Compaction (Subsurface Layers) | Cb | Cc | Cc | Ab |
| | Geochemical Characteristics | C | C | C | C |
| | Source -- Rate of Removal | C | C | C | C |
| Hydrology/ Geochemistry | Surface Discharge | Ba | Cb | Bc | Cc |
| | Surface Recharge | C | C | C | C |
| | Runoff in Relation to Total Hydrologic Budget | C | C | C | C |
| | Surface Quality | B | C | B | C |

TABLE 22. (Continued)

| Super-Title Category | Parameter Considered | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
|---|---|---|---|---|---|
| Hydrology/ Geochemistry (Continued) | Recharge to Aquifer | Ca | Cb | Cc | Ba |
| | Discharge to Surface (from Aquifers) | C | C | C | C |
| | Discharge to Surface (from Groundwater -- Baseflow only) | C | C | C | C |
| | Rate of Salt Water Intrusion (Aquifer Degradation) | Ca | Cb | Cc | Cc |
| | Vertical Permeability (Aquifers) | C | C | C | Bb |
| | Horizontal Permeability (Aquifers) | C | C | C | Ab |
| | Definition of Aquifer Characteristics | C | C | C | B |
| | Loss of Aquifer Capacity Due to Compaction | C | C | C | C |
| | Water Table in Relation to Surface (Depth) | Aa | Ab | Ab | Ab |
| | Velocity of Groundwater Flow (and Direction) | Ca | Cb | Cc | Cc |
| Meteorology | Precipitation | Aa | Ab | Ac | Ac |
| | Evaporation | C | C | C | C |
| | Infiltration in Relation to Vegetative Types | C | C | C | C |
| | Runoff in Relation to Vegetative Types | C | C | C | C |
| | Evapo-Transpiration | C | C | C | C |
| | Percolation in Relation to Vegetative Types | Ca | Cb | Cb | Ca |
| | Air Inversion | Ab | Ab | Ab | Ab |
| | Air Quality | C | C | C | C |
| | Flooding Due to Catastrophic Event | Aa | Ab | Ac | Ab |
| | Air Dispersion | Ab | Ab | Ab | Ab |
| Acoustical | Sound Attenuation | Aa | Ab | Ac | Ac |
| | Acoustical Focusing | Aa | Ab | Ac | Ac |
| Biotic Studies | Vegetative Components | Bb | Bb | Bb | Bb |
| | Vegetative Communities/ Segregants | C | C | C | C |
| | Vegetative Mapping | C | C | C | C |
| | Vegetative-Soil Correlations | C | C | C | C |
| | Vegetative Dynamics | C | C | C | C |
| | Faunal Survey | C | C | C | C |

TABLE 22. (Continued)

| Super-Title Category | Parameter Considered | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
|---|---|---|---|---|---|
| Biotic Studies (Continued) | Faunal Population Studies | C | C | C | C |
| | Aquatic Ecosystem Definition | C | C | C | Bb |
| | Terrestrial Ecosystem Definition | C | C | C | C |
| Facilities, etc. | Quality and Use of Facilities | N/A | N/A | N/A | Aa |
| | Integration of Facility Uses | N/A | N/A | N/A | Aa |
| | Utilities Capabilities | N/A | N/A | N/A | Aa |
| | Utilities Expansion Possible | Aa | Ba | Cc | Aa |
| | Transportation Availability | Aa | Ac | Ac | Aa |
| | Degree of Accessibility | Aa | Ac | Ac | Aa |
| | Support /Safety Services | Ab | Ac | Ac | Aa |
| | Degree of Remoteness from Public | Aa | Aa | Ab | Ac |

Analysis of Table 22 with weighted factors involves placing emphasis on groundwater, surface water, meteorologic, soils, and sediments characteristics. The following paragraphs will analyze the four zones of the MTF using the weighted parameter factors. Upon completion of these analyses, the comparative ratings for each zone will be evaluated against known land-use constraints within each zone.

The selection of, at minimum, (two) 100-acre sites and an alternative (pp. 266 to 293 ) and the field survey results will be made based on all of the above factors. This method reduces the importance of any one set of evaluations, but emphasizes the total value of:

(1) The specific 100-acre site itself (promotive as well as limiting factors).

(2) The zone within which the particular 100-acre site is located.

Again, as noted in the text previously, all symbol classifications used in Table 22 are arbitrary and could be modified by any of a series of factors. Factors of this order include the narrowing of the scope of types of tests and the kinds of hazardous materials to be used in the tests. We used this multiparameter analysis system as a general aid in rating the four zones of the MTF. A summary, by zone, using weighted analysis of each of the most important parameters (limiting as well as promotive) follows below.

## Notable Parameters in Zone 1 (Northeast MTF)

Analysis of all 61 parameters indicates Zone 1 to be reasonably well-defined and most adapted to the placement of an HMSE Test Center. Positive attributes of Zone 1 include an upward hydraulic gradient, moderate to poor drainage, low seepage rates, potentially high sediment ionic absorption rates, moderate to low runoff rates, very little erosion, a low seasonal flooding tendency, and favorable acoustical properties. In addition, the area is well-vegetated with a wide variety of tree, shrub and grass cover (indicating a high rate of vegetative recovery in relation to recent man-associated activities), and this zone offers a moderate range of topographic highs (sandy-clays) to the north and topographic lows (anaerobic, highly organic mucks) to the south. Vegetative recovery, when used in this report, refers to the ability of an area to return (after man-associated activity, such as cutting, clearing and draining) to either: 1) the original type and character of vegetative cover, and/or 2) a state similar or equivalent in function to the original vegetative cover. Original vegetative cover in this sense refers to that observed before a particular recent man-associated activity, e.g., logging, which is opposed to the vegetative cover that was present at the time of the earliest human settlement (pre-1700's) in the MTF area. With this definition in mind, qualitative and quantitative changes can be determined, both short and long-range as in the case of an HMSE impact; the original vegetative cover could be compared to that present after the HMSE test demonstration. The degree of recovery is dependent on the rate of succession for a particular plant community.

Zone 1 is most geographically removed from the influences of the Gulf (hurricanes, tropical storms, coastal environments, etc.), and is well buffered to the south by:

1. Zones 2, 3 and 4 (placing a thinly populated area of considerable distance between Zone 1 and the coastal environments towards the Gulf).

2. A series of sluggish, but relatively well-defined surface drainage areas (bayous, small streams choked with vegetation, etc.) between the potential testing area and the main stem Jourdan River.

These factors considered together allow the widest range of testing possible under varied, but potentially highly controllable, conditions; e.g., the sluggish surface drainage would tend to retard the flow of any accidentally released hazardous materials spills, thus providing adequate time for clean-up operations.

The area is close to existing MTF facilities, structures, and utilities, which could easily be incorporated or extended into the Zone 1 site location of a HMSE Test Center (also logging roads and fire lanes already provide reasonable access to large parts of Zone 1).

## Notable Parameters in Zone 2 (Southeast MTF)

Zone 2 in comparison to Zone 1 has the following characteristics:

1. Less topographic variation.
2. A greater flooding potential.
3. A greater probability of being more directly affected by hurricanes, tropical storm flooding, and associated damage.
4. A greater potential for sound focusing in this quadrant, when future static rocket firing experimentation is undertaken.
5. Zone 2 is the poorest-drained quadrant and may pose a problem if new testing facilities need to be constructed.
6. Air inversion tendency is greatest in this section.
7. Completely new transportation and utility systems would need to be constructed.
8. A closer proximity to the various delicate coastal environments.
9. Less geographic distance between the Zone 2 site and the main stem Bayou La Croix (flow rates and time factors are difficult to determine because of an intricate system of bayous and poorly defined drainage channels).
10. Less buffer area between the Zone 2 area and populated areas to the south and east of the MTF area.

Again, advantages such as sluggish drainage (Devil's Swamp), deep aquifers that are vertically removed from water table conditions (because of a thick clayey, organic substrate [low hydraulic conductivity]), and the thick vegetative cover (high regenerative rate) could function as valuable attributes, depending on what specific types of HMSE programs were selected.

## Notable Parameters in Zone 3 (Western MTF)

Zone 3 largely encompasses the Pearl River and its floodplain areas. Advantages in Zone 3 are generally limited to:

1. Cheap barge transportation directly to the Zone 3 site.
2. Ability to cope with a delicate ecosystem located near a main stem, major river.

These advantages are variable depending on the type of hazardous materials spills being considered. The environmental and physical drawbacks that limit the effectiveness of developing Zone 3 as an adequate and controllable site are:

1. Drainage characteristics in Zone 3 hinder the chance of recovering possible hazardous materials released into the floodplain environment.
2. Close proximity to the Pearl River and Mississippi Sound prevents development of large-scale HMSE operations in this zone.
3. Pearl River floodplain is periodically flooded by large spring runoffs from the upper reaches of the watershed and is also subjected to relatively large water level fluctuations caused by adverse climatic conditions (i.e., hurricanes and tropical storms).
4. High water tables in close proximity to a rapid rate surface runoff, in general, significantly reduce the potential of this locale as an adequate site for an HMSE Facility.

In addition to these factors, the Zone 3 area is least accessible via existing land transportation forms; the area possesses a series of swamp/bayou formations interspersed with a dense tangle of shrubs and vines (high reproductive rate but delicate in terms of regeneration and compositional balance), and the deep muck soils would probably hinder most construction activities. The buffer potential of this area is limited (houseboats on the Pearl, as well as more densely populated areas to the north and along a corridor towards the south).

Notable Parameters in Zone 4 (Southern Fee Area)

Zone 4 (refer to Figure 51 for a detailed map of this zone) is well developed and well defined. Advantages of the Zone 4 site in developing an HMSE Facility include:

1. Proximity to existing facilities and utilities.
2. Proximity to existing transportation systems.
3. Proximity to personnel, making this zone very convenient.
4. Surface drainage problems have been alleviated by previously constructed drainage systems.

5. Baseline conditions, although much altered from the natural, are best defined in Zone 4.

These advantages would be limited by four factors:

1. Surface runoff flows into the Canal System and subsequently into the Pearl River; subsurface drainage is thought to contribute to the Bayou La Croix Drainage. Thus, control of the Southern Fee Area hydrology is complicated by the interfacing of two separate flow systems.

2. Close proximity to the MTF Barge Canal may promote rapid runoff, which would reduce the chance of adequate clean-up in case of an accidental hazardous materials spill.

3. Close proximity to the personnel and visitors at the MTF, thus negating in part the effectiveness of a buffer zone.

4. Potential land-use/tenant-use problem involving coordination and overlap (to be described in detail elsewhere in this report).

## Comparative Analysis of the Four MTF Zones

The weighted factor analysis indicates Zone 1 (the Northeastern Buffer Zone) to be the area most adaptable to the establishment of a facility to test equipment to control hazardous materials spills. Additionally, the parameters most important to a test program are, at present, favorable in terms of controllability; e.g., well-defined surface drainage and upward hydraulic gradient, etc. For these reasons, a 100-acre site was selected for additional baseline investigations (see pp. 266 to 293).

In the event that the Zone 1 area is not available for development (it is currently being considered for a NASA-related activity, details of which were unavailable at the time of this study), an alternate 100-acre site in the Southeastern Buffer Zone was selected as the next most feasible area for development. The weighted factor analysis indicates this area to be controllable (hydrology, sediments, etc.); however, construction costs, flood preventative devices, and hurricane/tropical storm preventative controls must be considered as important. The area is hydric (Devil's Swamp) and contains a population of reptiles that are presently considered rare and/or endangered. For these reasons, the area was carefully surveyed and a 100-acre site selected for further baseline analysis (the site selected was chosen to minimize the negative qualities within the Zone 2 area). For results of the Zone 2 100-acre site field evaluations, see pp. 266 to 293.

A third area was selected for study, a minimum 100-acre site in the northern Fee Area (Zone 1). This was chosen because of proximity to buildings, structures, facilities, etc., in the central and southern Fee Area of the MTF.

Other areas were analyzed for potential site survey, these were rejected in favor of the three candidate sites which are described in Section 6 of this report. The USGS facilities were not studied in detail because of nearness to NASA activities and because of the generally limited availability of the flood facilities to a hazardous materials program. These three candidate sites were selected from Zones 1 and 2.

Finally, Zone 3 is rated as least amenable to development of an HMSE program (both the unweighted and weighted parameter analyses). Unstable floodplain conditions as well as groundwater conditions are rated as very significant negative factors for any type of structural development as well as landform modification. Zone 3 is not considered feasible for development, in part, because of the Canal System proximity and intended NASA Space Shuttle programs. No further evaluation of Zone 3 is made in the report.

## THE RESULTS OF ON-SITE SURVEY AND INVESTIGATIONS AT THREE CANDIDATE SITES

The following represents raw data, interpreted data, and information not presented in Section 6, Evaluation of Three Candidate Sites at the MTF. Three types of data were collected: Hydrologic, Soils and Vegetative. Data sheets are presented below (see pp. 18 to 44 for interpretive text).

### Hydrology and Soils Investigations

Calculations relating to groundwater depth (from surface elevations) are presented in Section 6 of this report. Calculations involved direct field measurements with extrapolation and interpolation of values beyond and between sample points. These values are presented in Table 23 for each of the stations sampled at Sites I, II and III.

Soils data are presented in Figures 67-79. The grain size distribution diagrams for soil samples collected at the three test sites: The Northeastern Buffer Zone site, the Southeastern Buffer Zone site, and the North-Central Fee Area site (see Figures 6, 8, and 10 for soil sample locations as well as observation and injection well locations). Section 6 also presents a brief evaluation/interpretation of the hydrology and soils findings.

## TABLE 23

## DEPTH TO GROUNDWATER DATA FOR SITES I, II, AND III, MISSISSIPPI TEST FACILITY, BAY ST. LOUIS, MISSISSIPPI (NOVEMBER 5-12, 1973)[a]

SITE I, Northeastern Buffer Zone (See Figure 6)

| STATION NUMBER | 5 NOV. 73 | 10 NOV. 73 | 12 NOV. 73 |
|---|---|---|---|
| 1 | 2.3 | 2.0 | 2.0 |
| 2 | 0.5 | 0.5 | 0.5 |
| 3 | 4.0 | 3.7 | 3.7 |
| 4a | 2.2 | 2.8 | 3.0 |
| 4b | 2.3 | 2.3 | 2.4 |
| 4c | 2.4 | 2.7 | 2.6 |
| 4d | 2.0 | 2.4 | 2.5 |
| 5 | 2.2 | 1.3 | 1.3 |
| 6 | Dry at 6.0 | Dry at 6.0 | Dry at 6.0 |
| 7 | 0.5 | 0.5 | 0.5 |
| 8 | Dry at 6.0 | Dry at 6.0 | Dry at 6.0 |
| 9 | 2.6 | 2.6 | 2.5 |

SITE II, Southeastern Buffer Zone Site (See Figure 8)

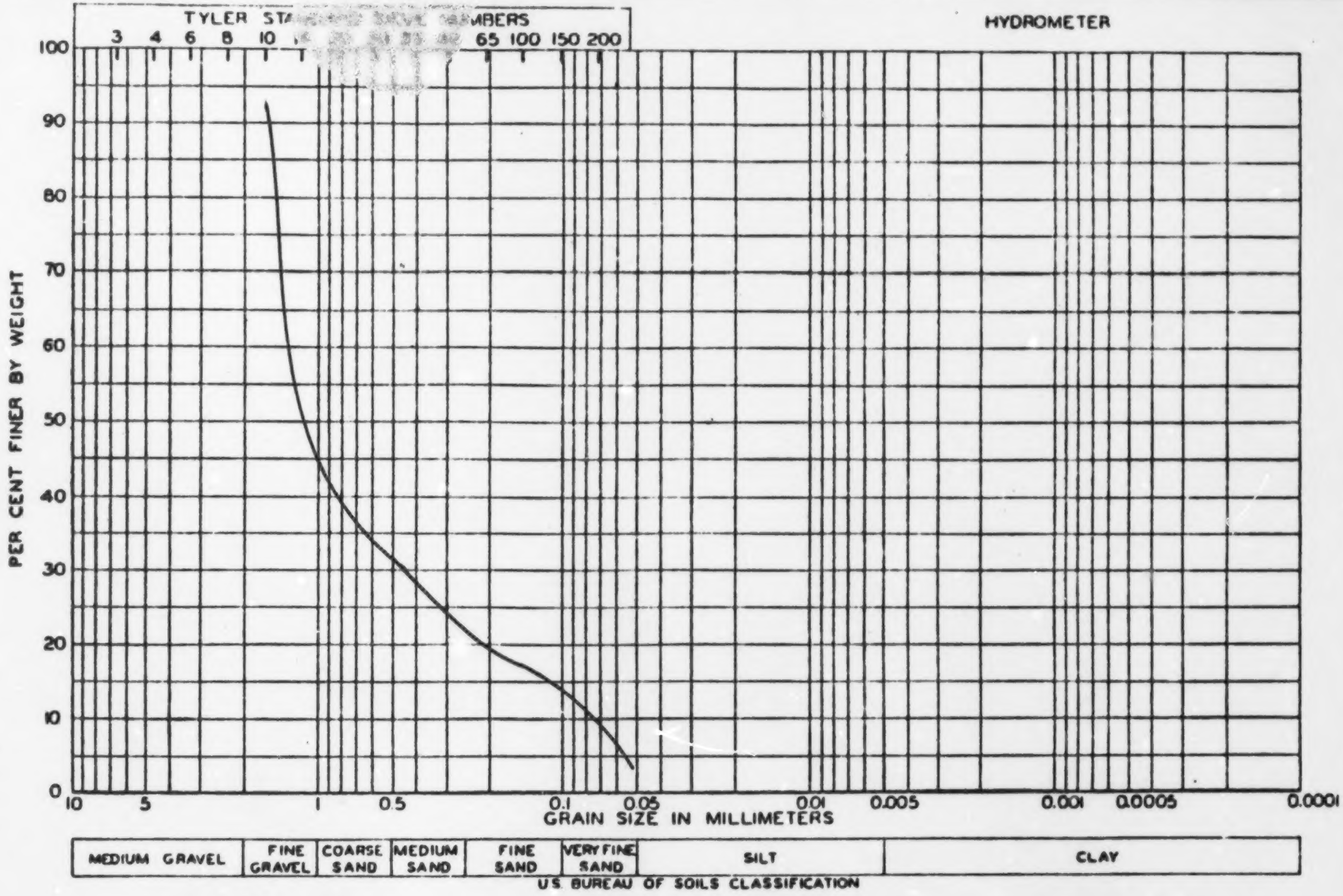
| STATION NUMBER | 5 NOV. 73 | 10 NOV. 73 | 12 NOV. 73 |
|---|---|---|---|
| 1 | NV | 0.6 | 0.6 |
| 2 | NV | 2.2 | 2.2 |
| 3 | NV | Dry at 4.0 | Dry at 4.0 |
| 4a | NV | 0.2 | 0.2 |
| 4b | NV | 0.2 | 0.2 |
| 4c | NV | 0.2 | 0.2 |
| 5 | NV | 1.3 | 1.3 |

SITE III, North-Central Fee Area Site (See Figure 10)

| STATION NUMBER | 5 NOV. 73 | 10 NOV. 73 | 12 NOV. 73 |
|---|---|---|---|
| 2 | NV | 2.0 | 2.0 |
| 3 | NV | 0.9 | 1.0 |
| 4 | NV | 0.8 | 1.2 |
| 5 | NV | 0.7 | 0.8 |

---

[a] Data from field determinations as described on pages 20-30 in Section 6; all measurements expressed in feet below surface elevations; and NV means no values for 5 Nov. 73.

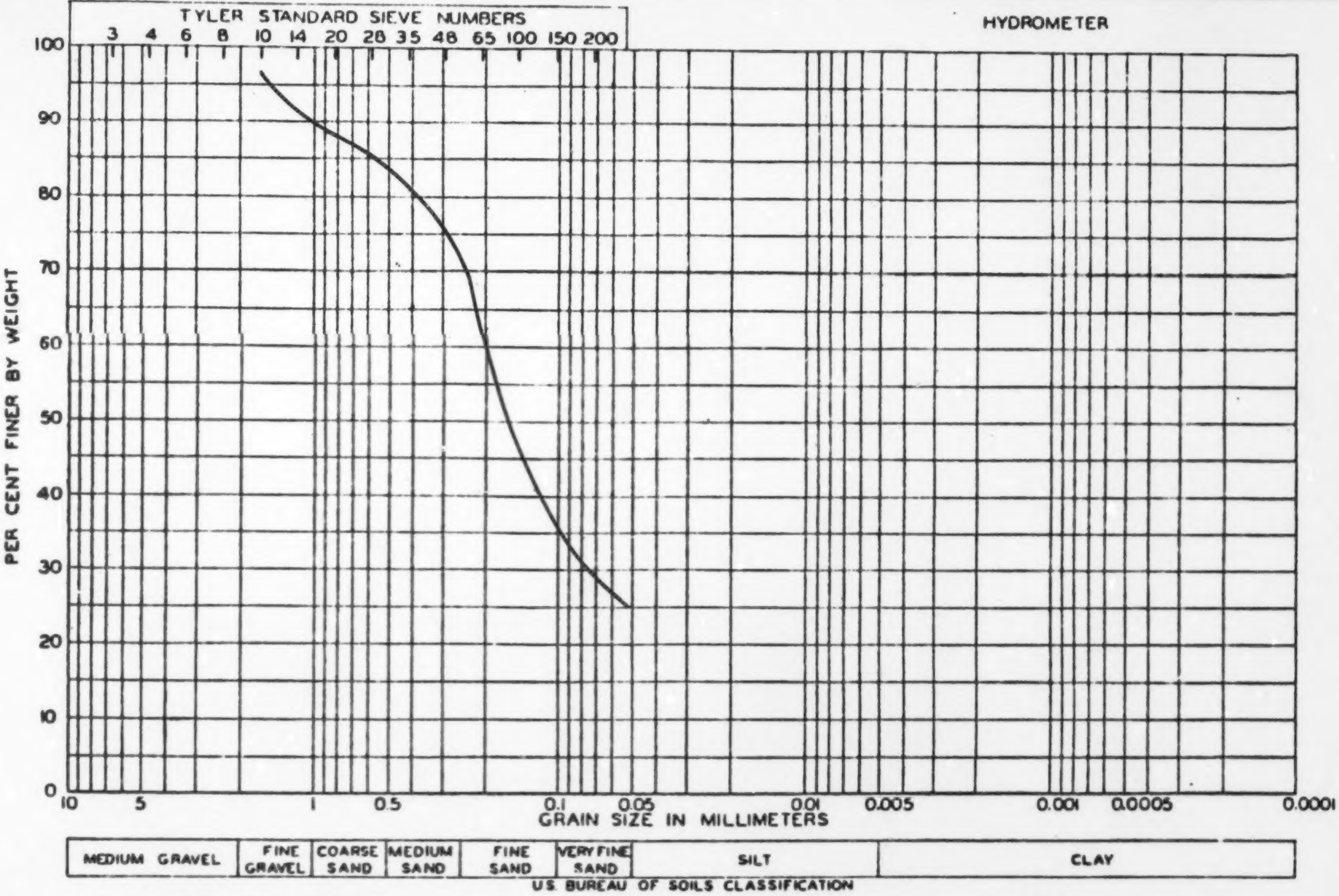


PROJECT The M.T.F. BORING NO ______ SAMPLE NO. 1-1

DEPTH 5 ft. ELEVATION ______ REMARKS ______

GRAIN SIZE DISTRIBUTION DIAGRAM

Figure 67

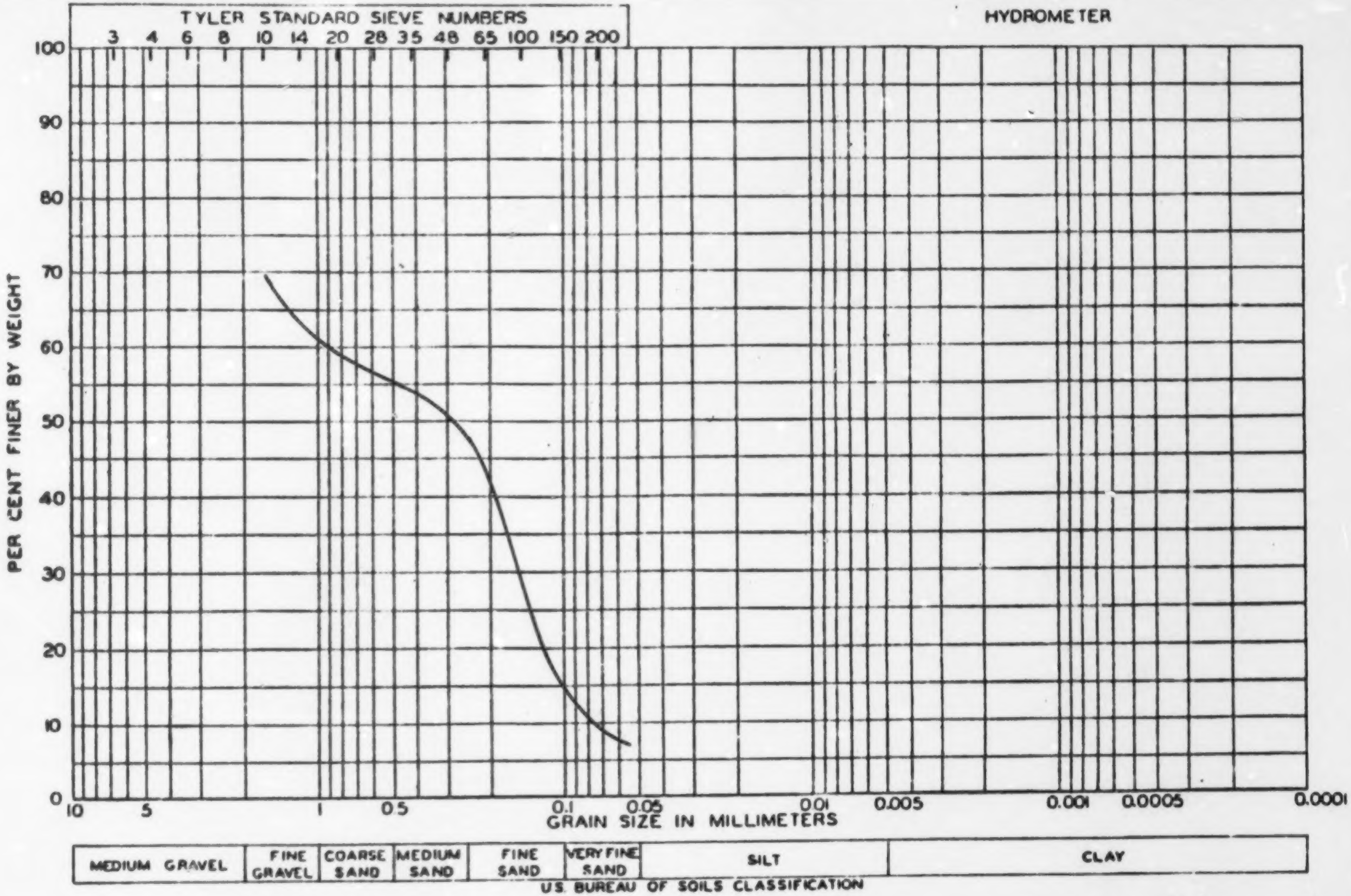


PROJECT The MIT.F. BORING NO ____ SAMPLE NO 1-3

DEPTH 5 ft. ELEVATION ____ REMARKS ____

GRAIN SIZE DISTRIBUTION DIAGRAM

Figure 68

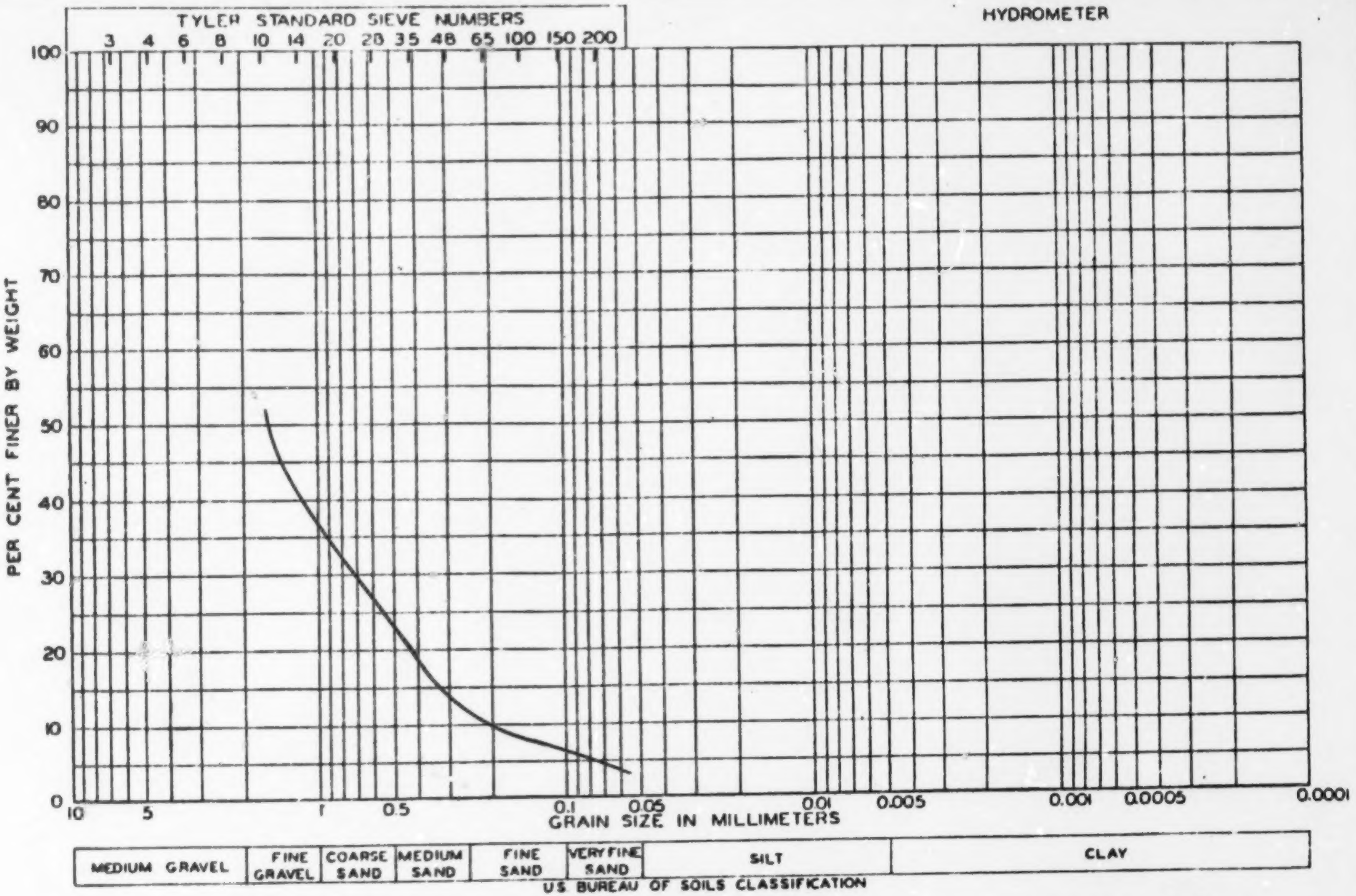


PROJECT The M.T.F. BORING NO ______ SAMPLE NO. 1-4

DEPTH 5 ft. ELEVATION ______ REMARKS ______

GRAIN SIZE DISTRIBUTION DIAGRAM

Figure 69

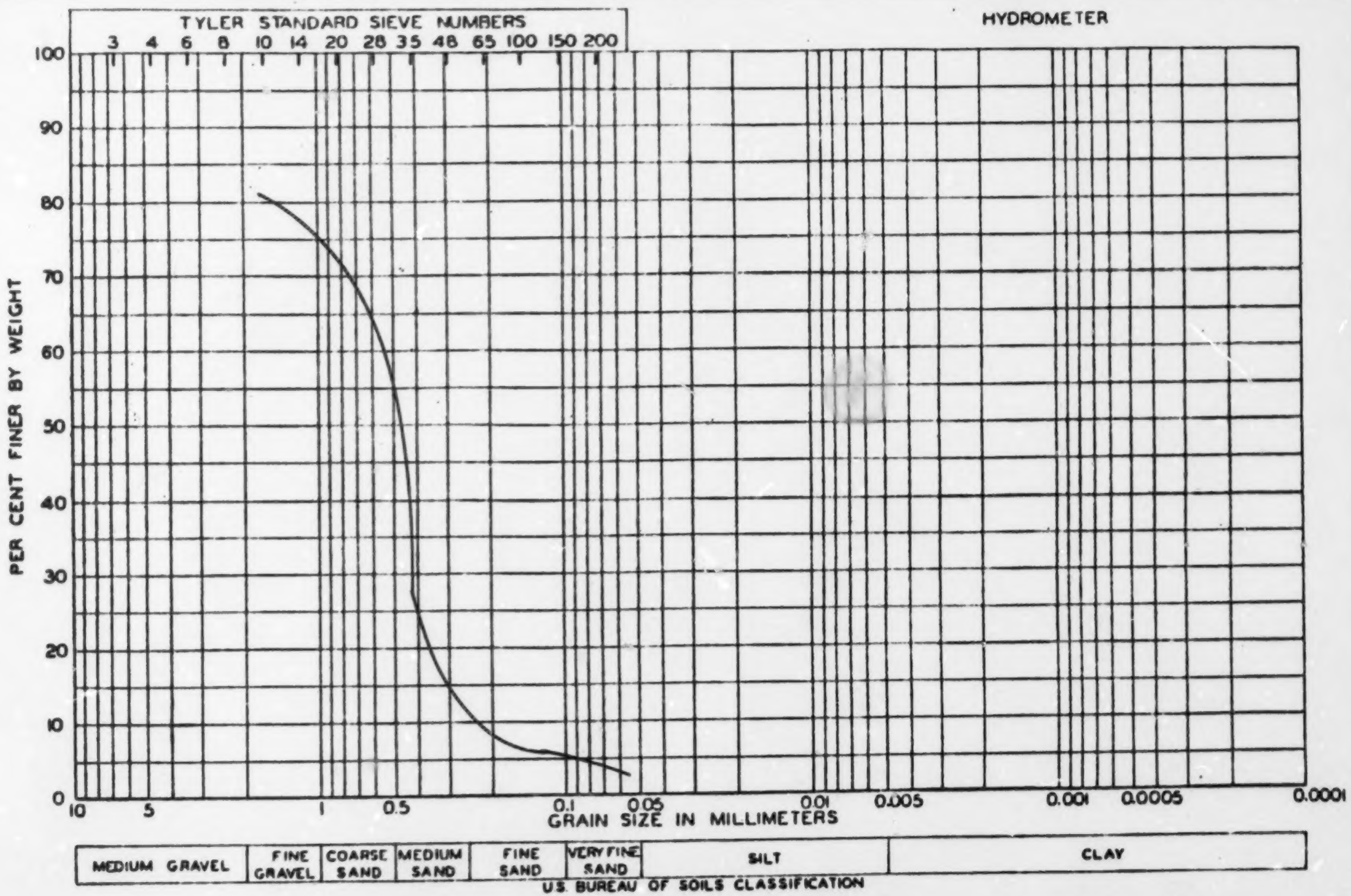


PROJECT The M.T.F. BORING NO ____ SAMPLE NO 1-5

DEPTH 5 ft. ELEVATION ____ REMARKS ____

GRAIN SIZE DISTRIBUTION DIAGRAM

Figure 70

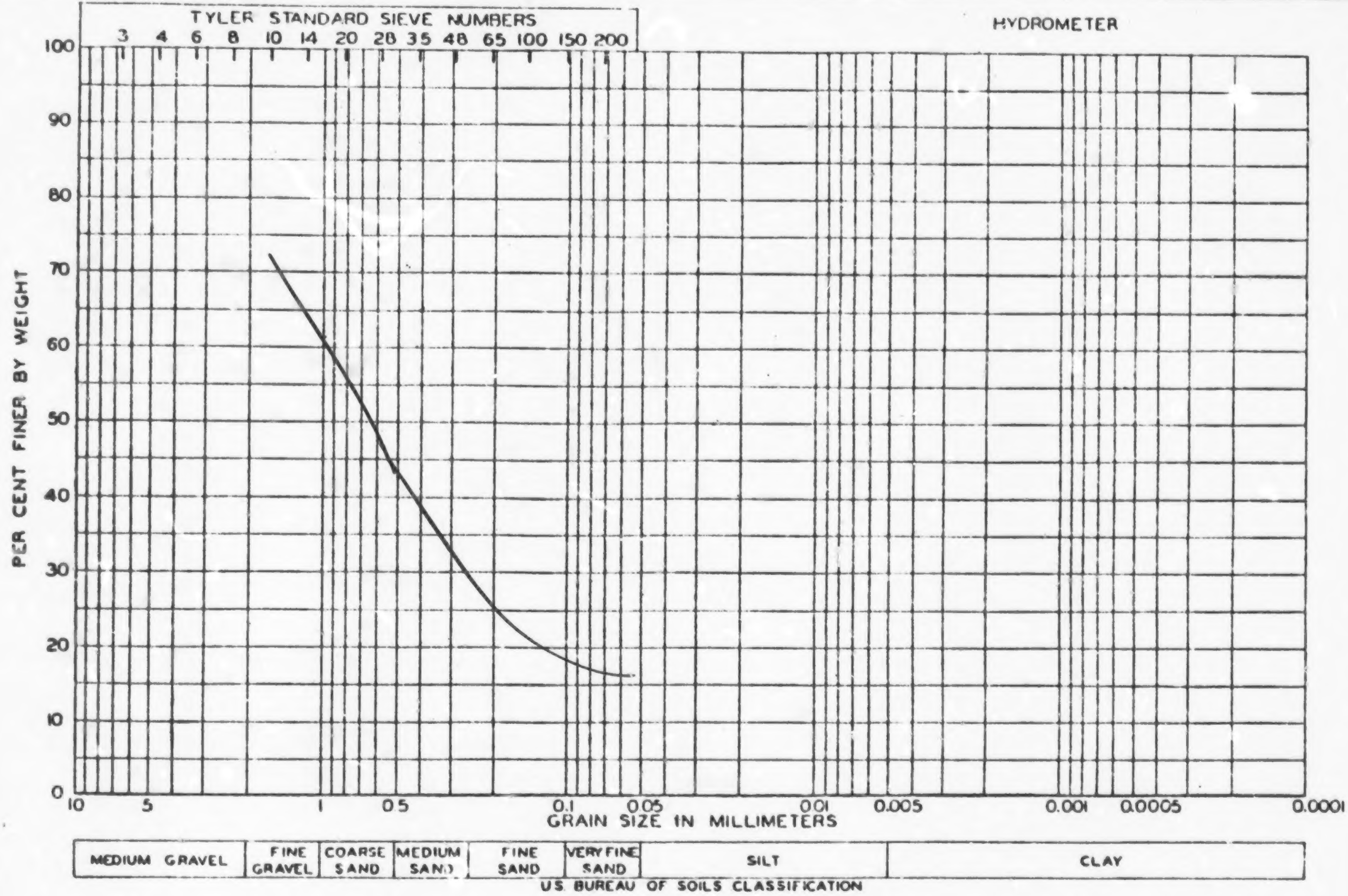


PROJECT The M.T.F. BORING NO ____ SAMPLE NO 2-1

DEPTH 5 ft. ELEVATION ____ REMARKS ____

GRAIN SIZE DISTRIBUTION DIAGRAM

Figure 71

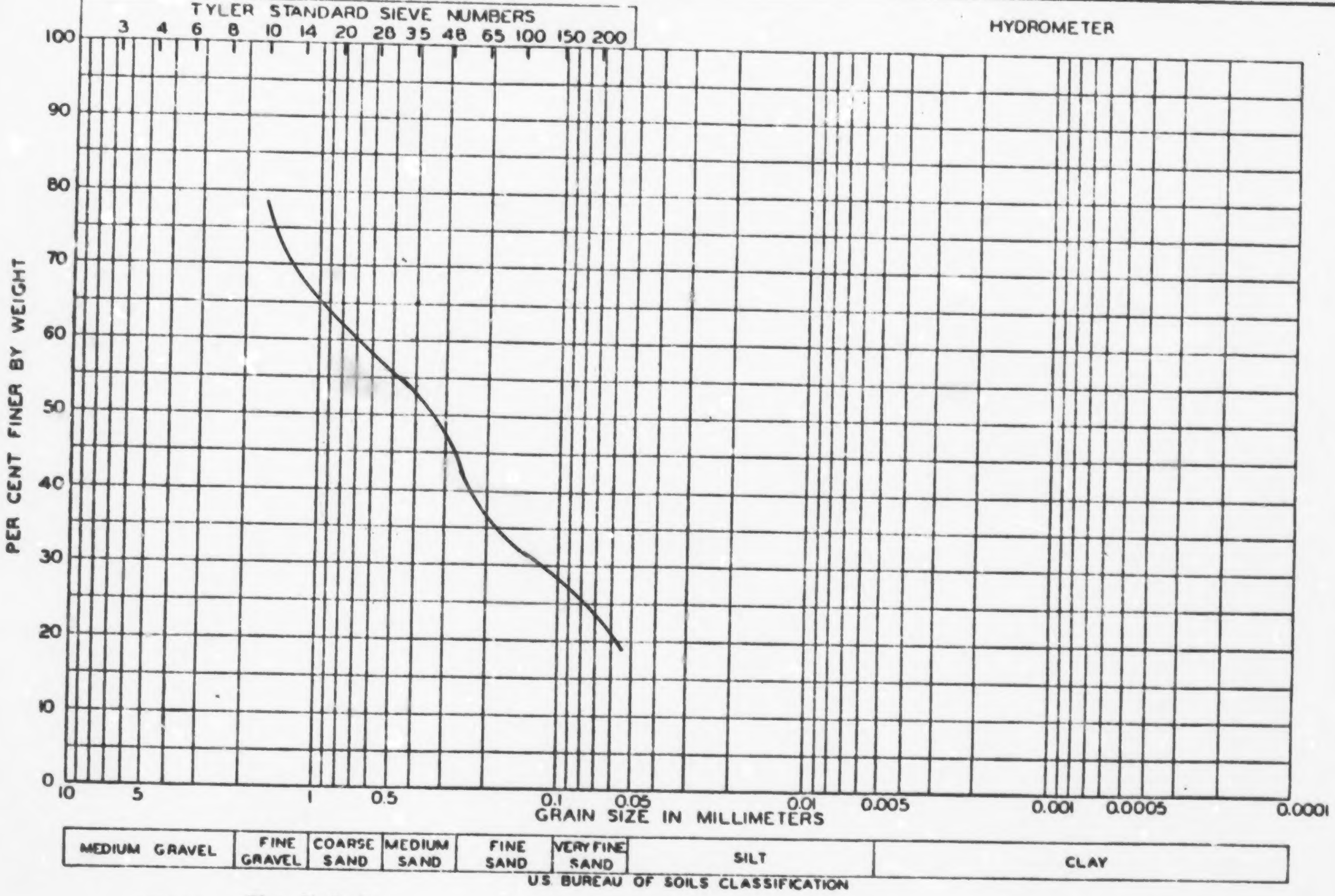


PROJECT The M.T.F. BORING NO ____ SAMPLE NO 2-2

DEPTH 5 ft. ELEVATION ____ REMARKS ____

GRAIN SIZE DISTRIBUTION DIAGRAM

Figure 72

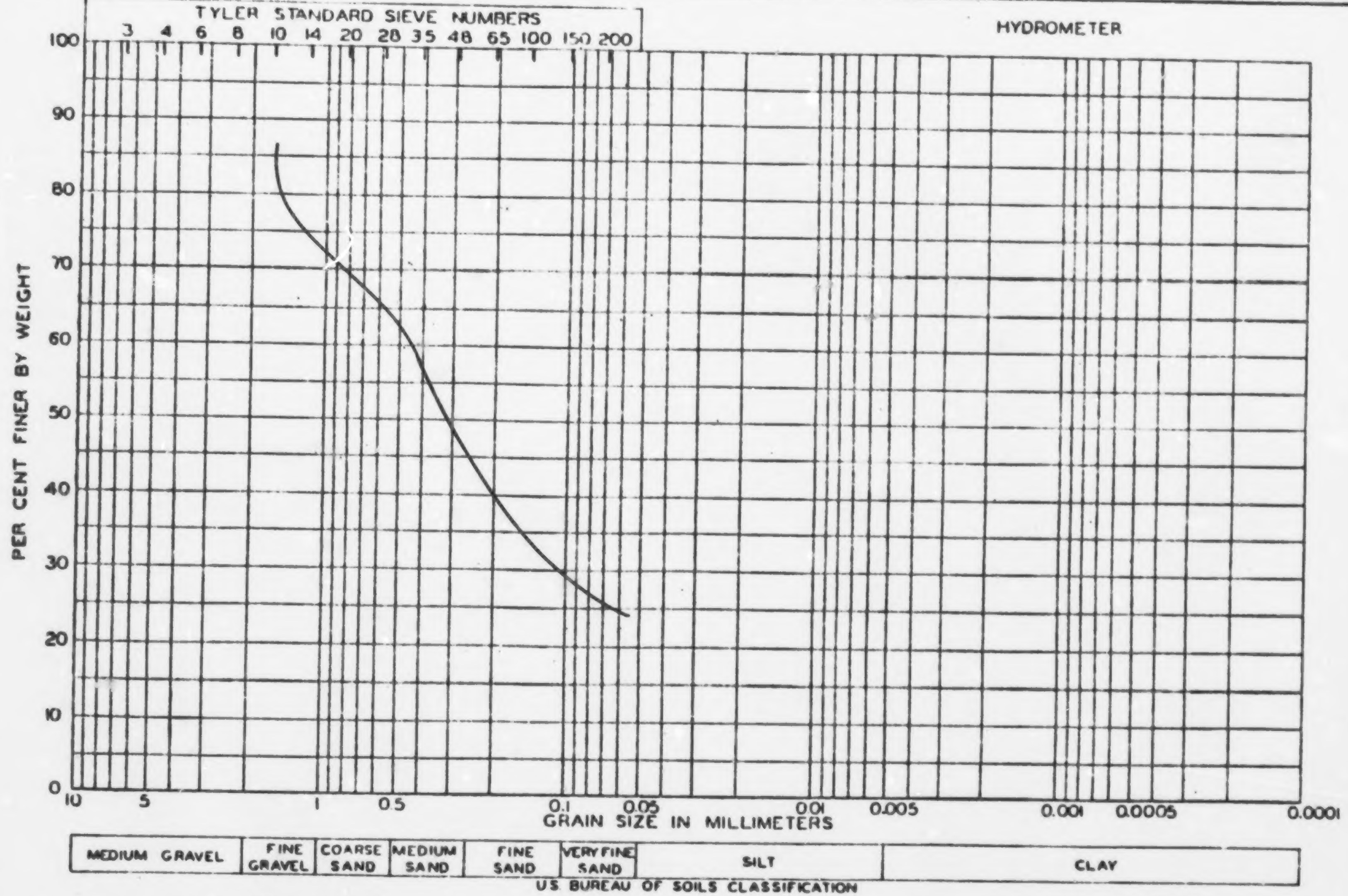


PROJECT The M.T.F. BORING NO ____ SAMPLE NO 2-3

DEPTH 5 ft. ELEVATION ____ REMARKS ____

GRAIN SIZE DISTRIBUTION DIAGRAM

Figure 73

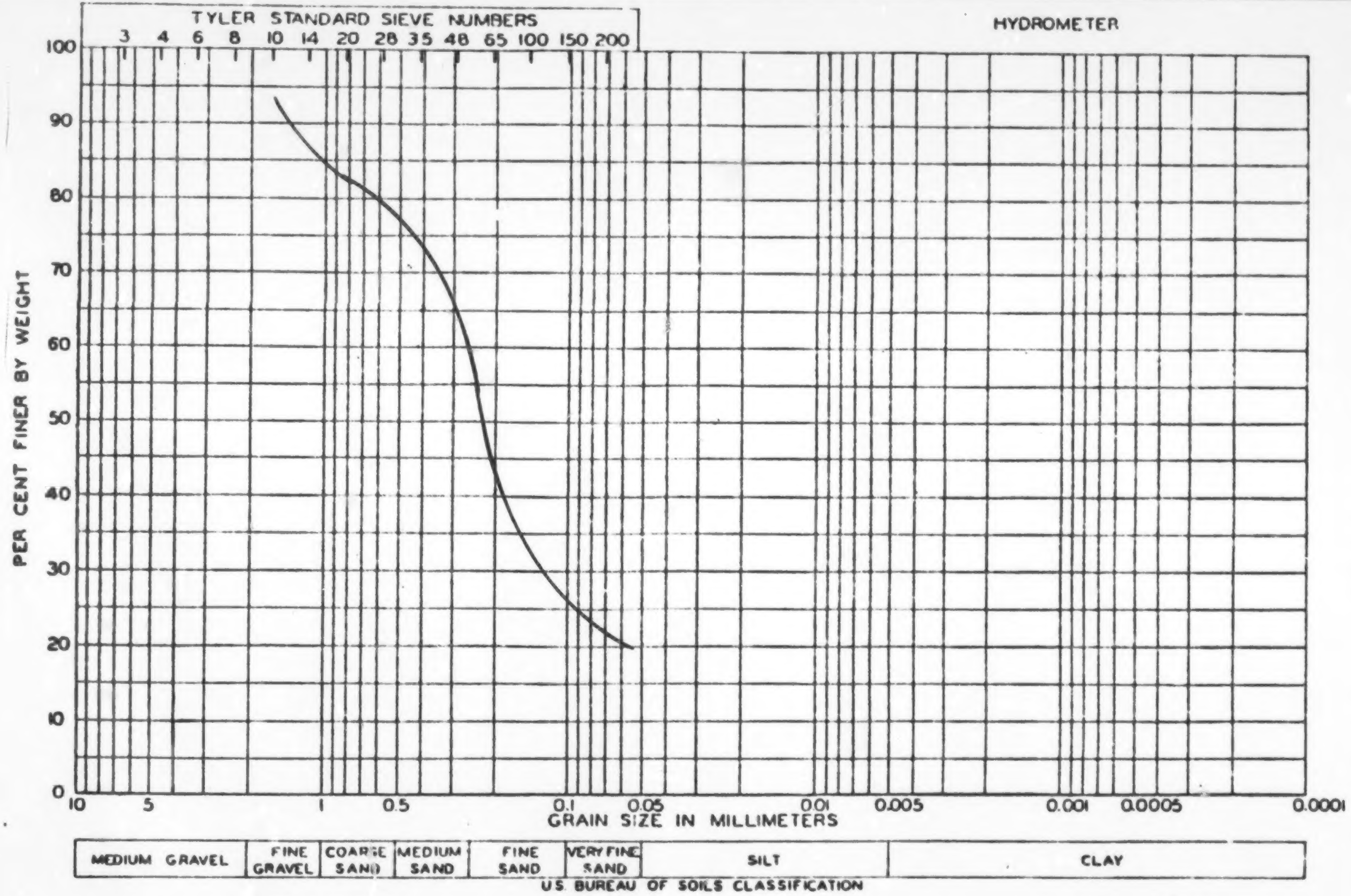


PROJECT The M.T.F. BORING NO ______ SAMPLE NO 2-4

DEPTH 5 ft. ELEVATION ______ REMARKS ______

GRAIN SIZE DISTRIBUTION DIAGRAM

Figure 74

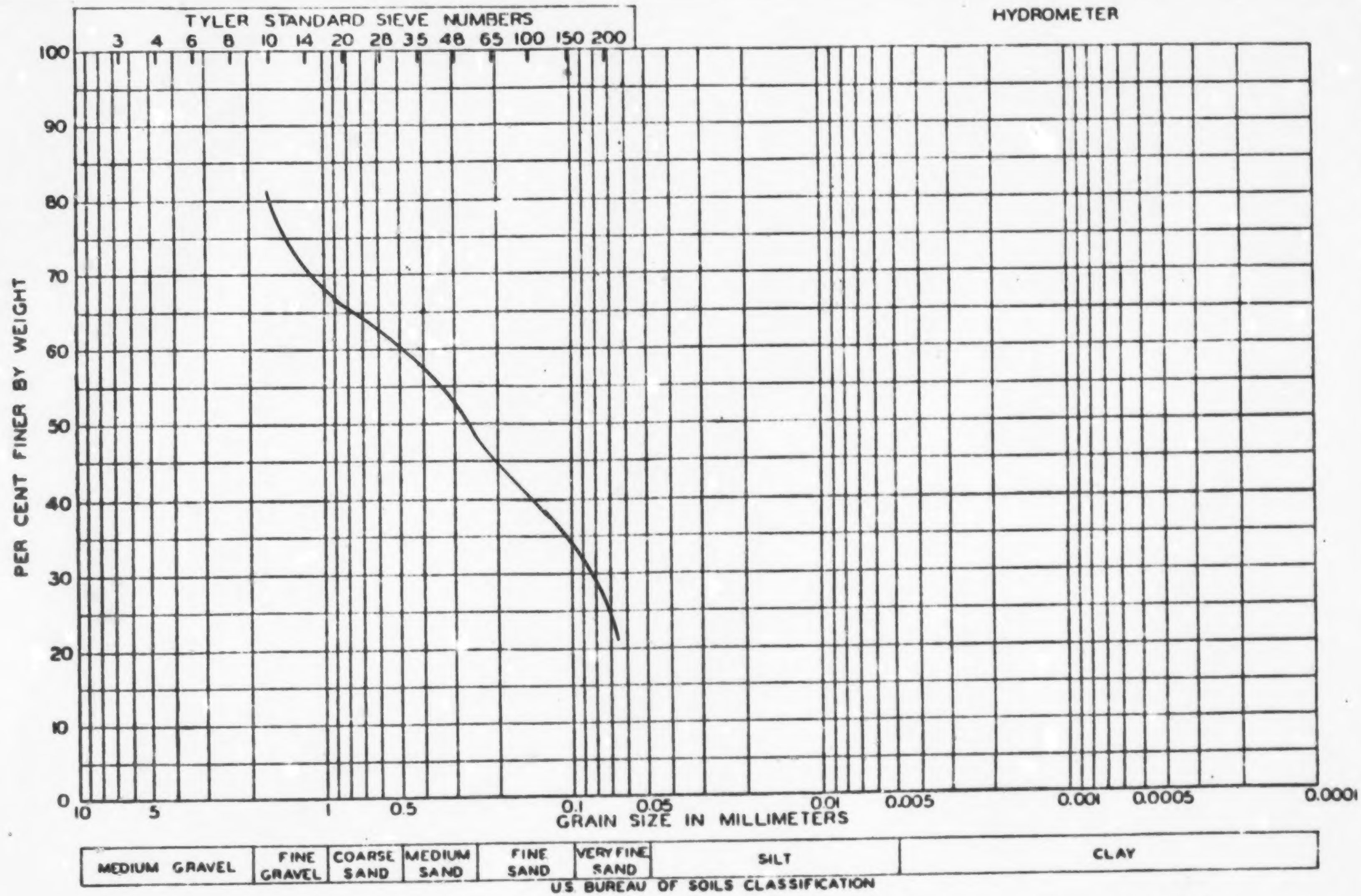


PROJECT The M.T.F. BORING NO ____ SAMPLE NO 2-5

DEPTH 5 ft. ELEVATION ____ REMARKS ____

GRAIN SIZE DISTRIBUTION DIAGRAM

Figure 75

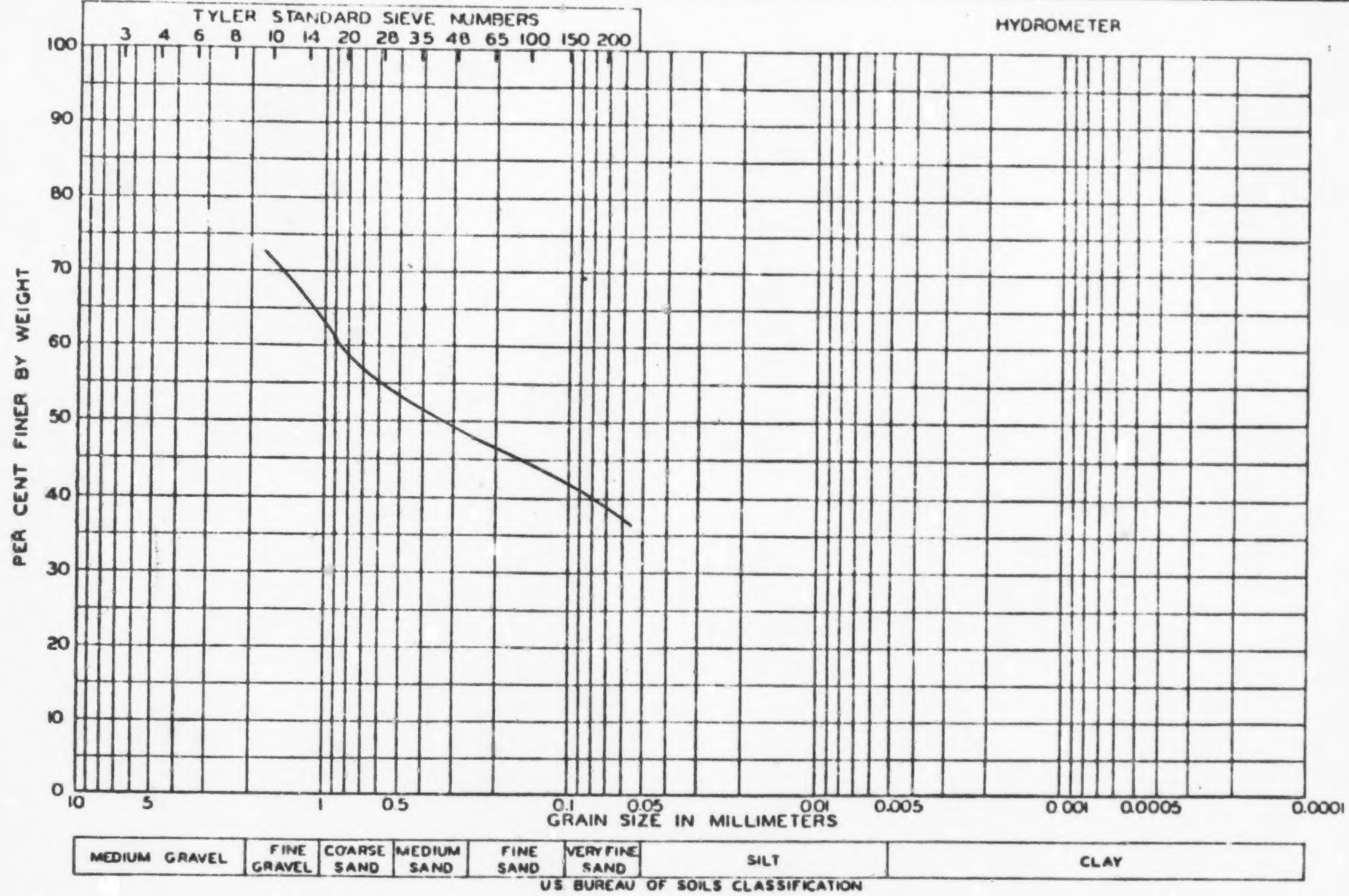


PROJECT The M.T.F. BORING NO ____ SAMPLE NO 3-1

DEPTH 5 ft. ELEVATION ____ REMARKS ____

GRAIN SIZE DISTRIBUTION DIAGRAM

Figure 76

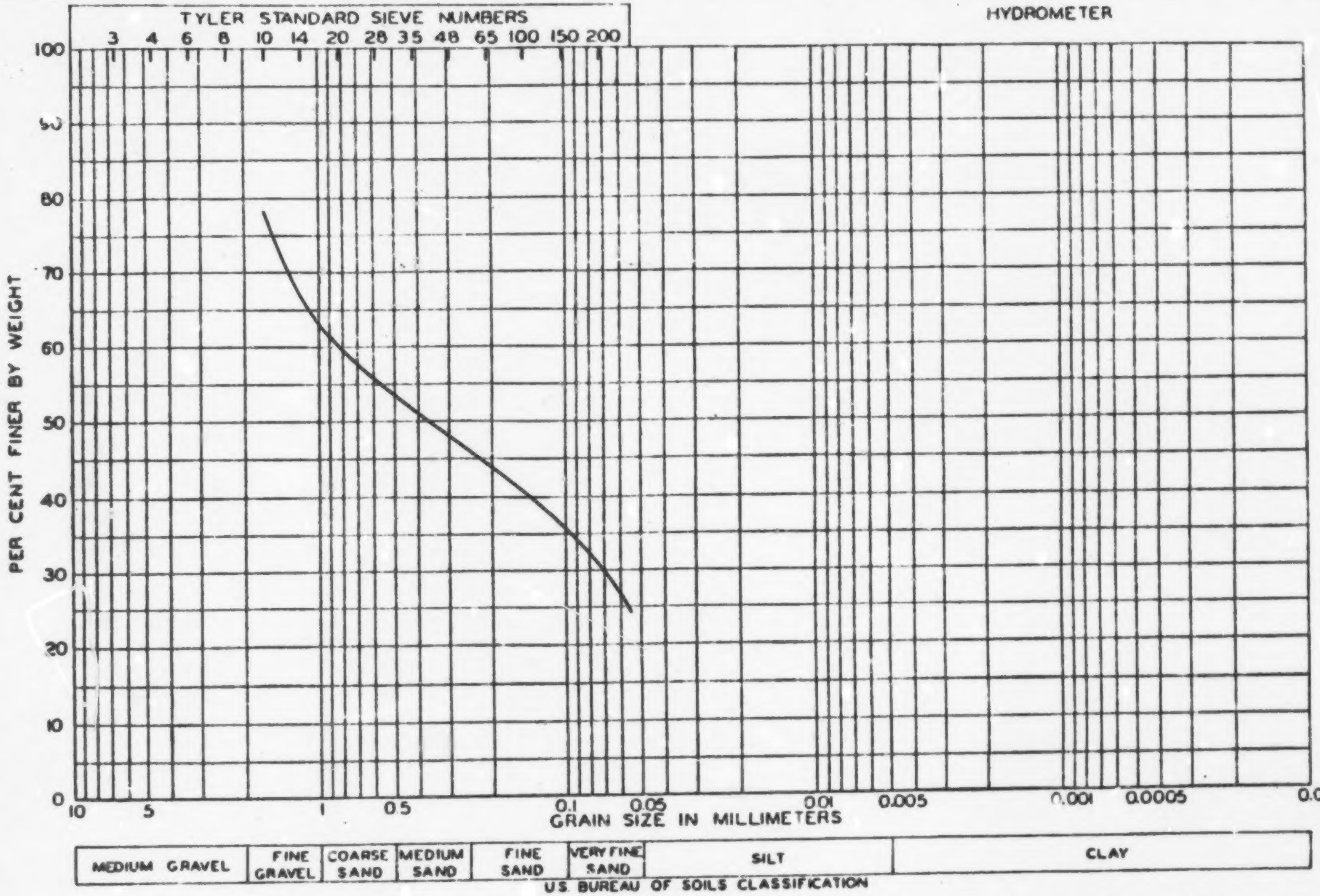


PROJECT The M.T.F. BORING NO ______ SAMPLE NO 3-2

DEPTH 5 ft. ELEVATION ______ REMARKS ______

GRAIN SIZE DISTRIBUTION DIAGRAM

Figure 77

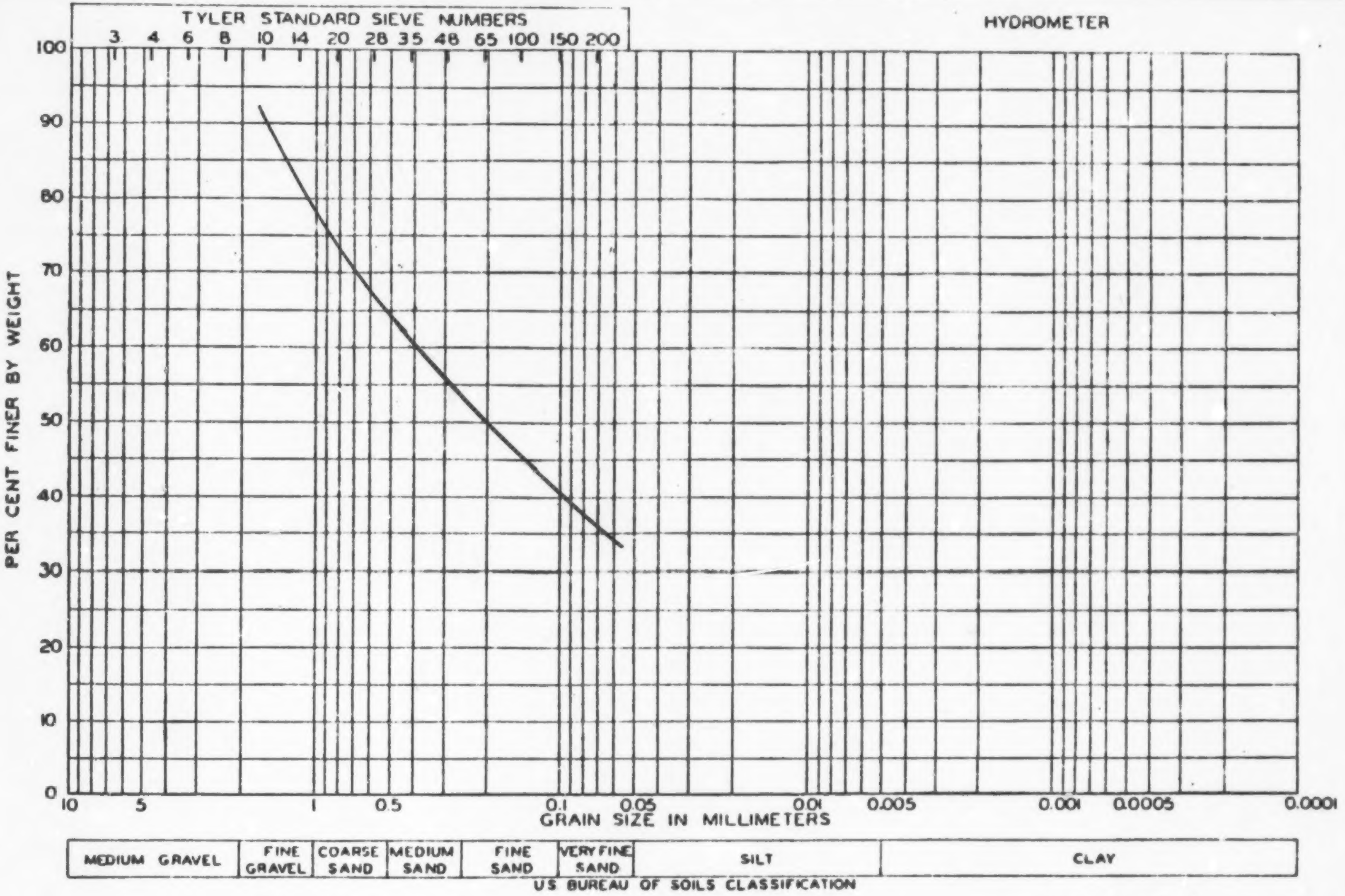


PROJECT The M.T.F. BORING NO ____ SAMPLE NO 3-3

DEPTH 5 ft. ELEVATION ____ REMARKS ____

GRAIN SIZE DISTRIBUTION DIAGRAM

Figure 78



PROJECT The M.T.F. BORING NO ____ SAMPLE NO 3-4

DEPTH 5 ft. ELEVATION ____ REMARKS ____

GRAIN SIZE DISTRIBUTION DIAGRAM

Figure 79

## Vegetative Investigations

Section 6 also presents a brief interpretive description of biotic conditions at each of the three candidate sites. Tables 24-27 illustrate the present raw and statistical data for the brief on-site observations of woody and herbaceous plant communities. Table 24 contains a listing of plants identified at the three sites. Table 25 shows the results of the ten factor prism determinations at the various segregants in each of the sites. Table 26 illustrates the tree core and dbh measurements at selected locations, and Table 27 gives averaged data for various ages and dbh's of selected woody species at selected locations. Maps showing locations can be found in Section 6: Figures 12, 13 and 14.

Interpretation of all data and observations during the brief period of field study is presented in Section 6. Time limitations as well as cost limitations dictated the need for brief field survey techniques. More detailed techniques are suggested in the later engineering design phases of the program.

## TABLE 24. PLANT SPECIES COLLECTED AT SITES I, II, AND III, MISSISSIPPI TEST FACILITY, BAY ST. LOUIS MISSISSIPPI (NOVEMBER 5-9, 1973)[a]

| VOUCHER NO. | FAMILY | FAMILY NO.[b] | SCIENTIFIC NAME | COMMON NAME | LOCATION | | |
|---|---|---|---|---|---|---|---|
| | | | | | SITE I | SITE II | SITE III |
| 1 | Sphagnaceae[c] | - | *Sphagnum* sp. | Sphagnum or Peat Moss | 1 | | |
| 2 | Polypodiaceae | 9 | *Adiantum* sp. | Maidenhair Fern | | | 3 |
| 3 | Polypodiaceae | 9 | *Asplenium platyneuron* | Ebony Spleen-wort | | | 3 |
| 4 | Polypodiaceae | 9 | *Onoclea sensibilis* | Sensitive Fern | 1 | | 3 |
| 5 | Polypodiaceae | 9 | *Polypodium polypodioides* | Polypody or Resurrection Fern | 1 | 2 | |
| 6 | Pinaceae | 13 | *Pinus elliottii* | Slash Pine | 1 | 2 | 3 |
| 7 | Pinaceae | 13 | *Pinus palustris* | Longleaf Pine | 1 | 2 | 3 |
| 8 | Pinaceae | 13 | *Pinus taeda* | Loblolly Pine | | 2 | 3 |
| 9 | Cupressaceae | 13a | *Juniperus virginiana* | Eastern Red Cedar | 1 | | |
| 10 | Taxodiaceae | 13b | *Taxodium distichum* | Bald Cypress | 1 | 2 | 3 |
| 11 | Gramineae | 22 | *Andropogon virginicus* var. *abbreviatus* | Broom-sedge | 1 | 2 | 3 |

TABLE 24. (Continued)
PLANT SPECIES COLLECTED AT SITES I, II, AND III
MISSISSIPPI TEST FACILITY, BAY ST. LOUIS, MISSISSIPPI
(NOVEMBER 5-9, 1973)[a] (Continued)

| VOUCHER NO. | FAMILY | FAMILY NO.[b] | SCIENTIFIC NAME | COMMON NAME | LOCATION | | |
|---|---|---|---|---|---|---|---|
| | | | | | SITE 1 | SITE II | SITE III |
| 12 | Gramineae | 22 | *Andropogon virginicus* var. *virginicus* | Broom-sedge | 1 | 2 | 3 |
| 13 | Gramineae | 22 | *Arundinaria tecta* | Cane | | | 3 |
| 14 | Bromeliaceae | 28 | *Tillandsia usneoides* | Spanish Moss | 1 | 2 | 3 |
| 15 | Liliaceae | 32 | *Lilium Catesbaei* | Pine Lily | | | 3 |
| 16 | Liliaceae | 32 | *Smilax* spp. | Greenbriers | 1 | 2 | 3 |
| 17 | Liliaceae | 32 | *Yucca filamentosa* | Adam's Needle | 1 | | |
| 18 | Salicaceae | 41 | *Populus* sp. | Cottonwood Poplar | | | 3 |
| 19 | Salicacaeae | 41 | *Salix* spp. | Willows | 1 | | 3 |
| 20 | Myricaceae | 42 | *Myrica cerifera* | Wax-myrtle | 1 | 2 | 3 |
| 21 | Juglandaceae | 44 | *Carya illinoensis* | Pecan | 1 | | |
| 22 | Juglandaceae | 44 | *Juglans nigra* | Black Walnut | 1 | | |
| 23 | Fagaceae | 46 | *Quercus* spp. | Oaks | 1 | 2 | 3 |

TABLE 24. (Continued)
PLANT SPECIES COLLECTED AT SITES I, II, AND III,
MISSISSIPPI TEST FACILITY, BAY ST. LOUIS, MISSISSIPPI
(NOVEMBER 5-9, 1973)[a] (Continued)

| VOUCHER NO. | FAMILY | FAMILY NO.[b] | SCIENTIFIC NAME | COMMON NAME | LOCATION SITE I | LOCATION SITE II | LOCATION SITE III |
|---|---|---|---|---|---|---|---|
| 24 | Fagaceae | 46 | *Quercus laurifolia* | Laurel Oak | 1 |  | 3 |
| 25 | Fagaceae | 46 | *Quercus marilandica* | Blackjack Oak | 1 | 2 |  |
| 26 | Fagaceae | 46 | *Quercus nigra* | Water Oak | 1 | 2 | 3 |
| 27 | Fagaceae | 46 | *Quercus phellos* | Willow Oak | 1 |  |  |
| 28 | Fagaceae | 46 | *Quercus virginiana* | Live Oak | 1 |  | 3 |
| 29 | Ulmaceae | 47 | *Celtis laevigata* | Sugarberry | 1 |  |  |
| 30 | Magnoliaceae | 67 | *Liriodendron tulipifera* | Tuliptree | 1 |  |  |
| 31 | Magnoliaceae | 67 | *Magnolia virginiana* | Sweet Bay, Swamp Bay | 1 | 2 | 3 |
| 32 | Sarraceniaceae | 75 | *Sarracenia flava* | Yellow Pitcher plant | 1 | 2 | 3 |
| 33 | Hamamelidacae | 80 | *Liquidamber styraciflua* | Sweet Gum, Red Gum | 1 | 2 | 3 |
| 34 | Platanaceae | 81 | *Platanus occidentalis* | Sycamore |  |  | 3 |

TABLE 24. (Continued)
PLANT SPECIES COLLECTED AT SITES I, II, AND III,
MISSISSIPPI TEST FACILITY, BAY ST. LOUIS, MISSISSIPPI
(NOVEMBER 5-9, 1973)[a] (Continued)

| VOUCHER NO. | FAMILY | FAMILY NO.[b] | SCIENTIFIC NAME | COMMON NAME | LOCATION SITE I | LOCATION SITE II | LOCATION SITE III |
|---|---|---|---|---|---|---|---|
| 35 | Rosaceae | 82 | *Prunus serotina* | Wild Black Cherry | 1 | | |
| 36 | Rosaceae | 82 | *Rubus* sp. | Black Berry | 1 | 2 | 3 |
| 37 | Leguminosae | 83 | *Wisteria* sp. | Wisteria | 1 | | |
| 38 | Euphorbiaceae | 92 | *Aleurites fordii* | Tungtree | 1 | | |
| 39 | Anacardiaceae | 97 | *Rhus copalinum* | Sumac | 1 | | |
| 40 | Anacardiaceae | 97 | *Rhus radicans* | Poison Ivy | 1 | 2 | |
| 41 | Anacardiaceae | 97 | *Rhus vernix* | Poison Sumac | 1 | | |
| 42 | Cyrillaceae | 98 | *Cyrilla racemiflora* | Southern Leatherwood or Ironwood | 1 | 2 | 3 |
| 43 | Aquifoliaceae | 99 | *Ilex coriacea* | Gallberry | 1 | 2 | 3 |
| 44 | Aquifoliaceae | 99 | *Ilex opaca* | Holly | 1 | 2 | 3 |
| 45 | Aquifoliaceae | 99 | *Ilex vomitoria* | Yaupon | 1 | 2 | 3 |
| 46 | Aceraceae | 102 | *Acer rubrum* | Red Maple | 1 | | 3 |
| 47 | Vitaceae | 107 | *Vitis rotundifolia* | Southern Fox-grape | 1 | | |
| 48 | Nyssaceae | 122 | *Nyssa biflora* | Water Gum | 1 | 3 | |

TABLE 24. (Continued)
PLANT SPECIES COLLECTED AT SITES I, II, AND III
MISSISSIPPI TEST FACILITY, BAY ST. LOUIS, MISSISSIPPI
(NOVEMBER 5-9, 1973)[a] (Continued)

| VOUCHER NO. | FAMILY | FAMILY NO.[b] | SCIENTIFIC NAME | COMMON NAME | LOCATION<br>SITE I | <br>SITE II | <br>SITE III |
|---|---|---|---|---|---|---|---|
| 49 | Nyssaceae | 122 | Nyssa sylvatica | Black Gum, Sour Gum | 1 | 2 | 3 |
| 50 | Cornaceae | 130 | Cornus florida | Flowering Dogwood | 1 | | |
| 51 | Ericaceae | 133 | Vaccinium sp. | Huckleberry | 1 | | |
| 52 | Loganiaceae | 142 | Gelsemium sempervirens | Yellow Jessamine | 1 | | |
| 53 | Apocynaceae | 144 | Nerium oleander | Oleander | | | 3 |
| 54 | Verbenaceae | 150 | Verbena sp. | Blue Vervain | 1 | | 3 |
| 55 | Labiatae | 151 | Salvia spp. | Salvia | 1 | 2 | 3 |
| 56 | Scrophulariaceae | 153 | Mimulus sp. | Monkey Flower | 1 | | 3 |
| 57 | Caprifoliaceae | 162 | Lonicera japonica | Vine Honeysuckle | 1 | 2 | 3 |
| 58 | Caprifoliaceae | 162 | Viburnum sp. | Viburnum, Arrow-wood | 1 | | |
| 59 | Compositae | 168 | Aster spp. | Asters | 1 | 2 | 3 |
| 60 | Compositae | 168 | Bidens spp. | Beggar-ticks | 1 | 2 | 3 |
| 61 | Compositae | 168 | Eupatorium-coelestinum | Blue-boneset, Ageratum | 1 | 3 | |

TABLE 24 (Continued)
PLANT SPECIES COLLECTED AT SITES I, II, AND III,
MISSISSIPPI TEST FACILITY, BAY ST. LOUIS, MISSISSIPPI
(NOVEMBER 5-9, 1973)[a] (Continued)

| VOUCHER NO. | FAMILY | FAMILY NO.[b] | SCIENTIFIC NAME | COMMON NAME | LOCATION<br>SITE I | <br>SITE II | <br>SITE III |
|---|---|---|---|---|---|---|---|
| 62 | Compositae | 168 | Grindelia sp. | Gum Plant | | | 3 |
| 63 | Compositae | 168 | Liatris sp. | Blazing Star | 1 | | |
| 64 | Compositae | 168 | Rudbeckia sp. | Black-eyed Susan | 1 | | 3 |
| 65 | Compositae | 168 | Solidago spp. | Goldenrods | 1 | 2 | 3 |
| 66 | Compositae | 168 | Stokesia laevis | Stokesia | | | 3 |

[a] Plant keys include the following: Fernald (1950), Gleason and Cronquist (1963), Harrar and Harrar (1962) and Weishaupt (1968). Assistance in identification included the help of the Mississippi State University students and researchers at the MSU-MTF Research Center.

[b] Family numbers according to Fernald (1950).

[c] Division - Bryophyta, Class - Musci, Order - Sphagnales (non-vascular).

Total Vouchers = 66
Total Families = 35
Total Genera = 53

## TABLE 25. TEN FACTOR PRISM DETERMINATIONS OF THREE WOODY COMMUNITIES USING THE MODIFIED BITTERLICH-GROSENBAUGH TECHNIQUE

| LOCATION[a] | NO. OF POINTS | SPECIES | BA[b] | F | RBA | RF | IV |
|---|---|---|---|---|---|---|---|
| Site I - Mixed Broadleaf Community | 7 | *Pinus palustris* | 35.72 | 5 | 47.17 | 27.78 | 74.95 |
| | | *Magnolia virginiana* | 28.57 | 7 | 37.74 | 38.89 | 76.63 |
| | | *Acer rubrum* | 4.28 | 2 | 5.66 | 11.11 | 16.77 |
| | | *Nyssa sylvatica* | 4.28 | 2 | 5.66 | 11.11 | 16.77 |
| | | *Liriodendron tulipifera* | 2.86 | 2 | 3.77 | 11.11 | 14.88 |
| Site I - Longleaf Pine Areas | 4 | *Pinus palustris* | 77.50 | 4 | 100.00 | 100.00 | 200.00 |
| Site II - Slash Pine Areas | 9 | *Pinus elliottii* | 42.22 | 9 | 97.44 | 90.00 | 187.44 |
| | | *Nyssa sylvatica* | 1.11 | 1 | 2.56 | 10.00 | 12.56 |

TABLE 25 (Continued) TEN FACTOR PRISM DETERMINATIONS OF THREE WOODY COMMUNITIES USING THE MODIFIED BITTERLICH-GROSENBAUGH TECHNIQUE

| LOCATION[a] | NO. OF POINTS | SPECIES | BA[b] | F | RBA | RF | IV |
|---|---|---|---|---|---|---|---|
| Site III - Slash Pine Areas | 21 | *Pinus elliottii* | 59.05 | 21 | 98.41 | 91.30 | 189.71 |
| | | *Taxodium distichum* | 0.48 | 1 | 0.79 | 4.35 | 5.14 |
| | | *Nyssa sylvatica* | 0.48 | 1 | 0.79 | 4.35 | 5.14 |

[a] See Figures 12, 13 and 14 for mapped locations. Technique modified from Bitterlich (1948) and Grosenbaugh (1952).

[b] Formulae and symbols as follows:

$$\text{Basal Area (BA)} = 10\left[\frac{\text{No. stems of taxon counted in all points}}{\text{No. of points in segregant}}\right]$$

Frequency (F)= No. of points at which a taxon was observed.

$$\text{Relative Basal Area (RBA)} = 100\left[\frac{\text{No. stems of each taxon in segregant}}{\text{Total stems all taxa in segregant}}\right]$$

$$\text{Relative Frequency (RF)} = 100\left[\frac{\text{F of a taxon in segregant}}{\text{Total F of all taxa in segregant}}\right]$$

Importance Value (IV) = RBA + RF

## TABLE 26 TREE CORE (Annual Increment Cores) RECORD FOR THE THREE CANDIDATE SITES AT THE MTF[a]

| SAMPLE NO. | SPECIES | dbh | LOCATION | ESTIMATED AGE |
|---|---|---|---|---|
| 11-7-73-1 | *Pinus palustris* | 4.2 | Near stream - center of burned area<br>SITE I | 17 yrs. |
| 11-7-73-2 | " " | 2.8 | Seed tree in burned area<br>SITE I | 12 yrs. |
| 11-7-73-3 | " " | 5.0 | NE Population<br>SITE I | 17 yrs. |
| 11-7-73-4 | " " | 4.8 | North Valley<br>SITE I | 27 yrs. |
| 11-7-73-5 | " " | 4.3 | NW Seed tree<br>SITE I | 24 yrs. |
| 11-8-73-1 | *Pinus elliottii* | 5.0 | North end of Access Rd.<br>SITE II | 9 yrs. |
| 11-8-73-2 | " " | 13.3 | Along Access Road<br>SITE II | 24 yrs. |
| 11-8-73-3 | " " | 7.4 | SE Portion of Site<br>SITE II | 23 yrs. |
| 11-8-73-4 | " " | 13.2 | Topographic High<br>SITE II | 25 yrs. |
| 11-8-73-5 | " " | 13.6 | Topographic High | $20^{+}$yrs. |

TABLE 26 (Continued) TREE CORE (Annual Increment Cores) RECORD
FOR THE THREE CANDIDATE SITES
AT THE MTF[a]

| SAMPLE NO. | SPECIES | dbh | LOCATION | ESTIMATED AGE |
|---|---|---|---|---|
| 11-8-73-6 | Pinus elliottii | 5.9 | Young Grove SITE III | 13 yrs. |
| 11-8-73-7 | " " | 8.2 | Older Grove (NE) SITE III | 22 yrs. |
| 11-8-73-8 | " " | 6.0 | Central Grove SITE III | 12 yrs. |
| 11-8-73-9 | " " | 9.2 | SE Grove SITE III | 14 yrs. |
| 11-8-73-10 | Taxodium distichum | 4.2 | SE Grove SITE III | 13 yrs. |

[a] Tree corer used were 36", trees selected as representative of scattered sites, and ages estimated. dbh, diameter at breast height (in inches) and cores sent to National Tree Core Laboratory (USGS) in Washington, D.C. See Figures 12, 13 and 14 for locations.

## TABLE 27. REPRESENTATIVE AGES AND dbh's AT SELECTED LOCATIONS AT THE THREE CANDIDATE SITES AT THE MTF

| AVERAGE VALUE[a] Age | AVERAGE VALUE[a] dbh | WOODY SPECIES SAMPLED | NUMBER OF SAMPLES | LOCATION | TECHNIQUE OF SAMPLING |
|---|---|---|---|---|---|
| - | 1.4"-3.2"<br>2.5" | *Pinus palustris* | 4 | Site I, South Valley-Mixed Broadleaf Community | Actual Measure |
| - | <1"-12" | *Magnolia virginiana* | 10+ | " | Estimated Measure |
| - | <1"-4' | *Taxodium distichum* | 5+ | " | Estimated Measure |
| - | 4"-2'<br>6.2" | *Liriodendron tulipfera* | 3 | " | Actual Measure |
| - | 1"-4.5" | *Acer rubrum* | 5+ | " | Estimated Measure |
| - | 1.5"-24.0"<br>5.27" | *Pinus palustris* | 15 | Site I, Pines in North Valley | Actual Measure |
| - | 2.5"-8.0"<br>4.79" | *Pinus palustris* | 12 | Site I, NE Groves along periphery | Actual Measure |
| 14-50+ yrs.<br>23.83 yrs. | 5.5"-30"<br>14.75" | *Pinus palustris* | 6 | Site I, North & NE Groves | Stump Measurements |
| 4-6 yrs.<br>5.17 yrs. | - | *Pinus palustris* | 6 | Site I, old field south of Access Road | Bud scale Measurements |
| 12-27 yrs.<br>19.4 yrs. | 2.8"-5.0"<br>4.22" | *Pinus palustris* | 5 | Site I, all Longleaf sites | Actual cores & Measurements |

TABLE 27. REPRESENTATIVE AGES AND dbh's AT SELECTED
(Cont'd) LOCATIONS AT THE THREE CANDIDATE SITES AT THE MTF

| AVERAGE VALUE[a] Age | AVERAGE VALUE[a] dbh | WOODY SPECIES SAMPLED | NUMBER OF SAMPLES | LOCATION | TECHNIQUE OF SAMPLING |
|---|---|---|---|---|---|
| - | <1"-4.9"<br>3.31" | *Pinus elliottii* | 10 | Site II, Slash Pine Groves (all areas) | Actual Measurements |
| 9-25 yrs.<br>20.2 yrs. | 5-13.6"<br>10.5" | *Pinus elliottii* | 5 | Site II, Slash Pine Groves (all areas) | Actual Cores & Measurements |
| - | 5.7"-9.8"<br>7.05" | *Pinus elliottii* | 20 | Site III, Slash Pine Groves ( all areas) | Actual Measurements |
| 12-22 yrs.<br>15.25 yrs. | 4.2"-8.2"<br>7.32" | *Pinus elliottii* | 4 | Site III, Slash Pine Groves (all areas) | Actual Cores & Measurements |
| - | 3.9"-9.0"<br>5.7" | *Taxodium distichum* | 3 | Site III, Slash Pine Groves (all areas) | Actual Measurements |
| 13 yrs. | 4.2" | " " | 1 | Site III Slash Pine Groves (all areas) | Actual Cores & Measurements |

[a] Age estimated by count of annual increment rings; dbh, diameter at breast height in inches except where indicated in Technique column as "stump measurements"--these being at ground level (recently harvested trees); and values in inches except where indicated as feet or years -- range (minimum-maximum values) on top and average value at bottom of each box.

# APPENDIX D

# ANALYSIS OF OPEN, SEMI-CLOSED AND CLOSED TESTING ELEMENTS FOR TESTING, DEMONSTRATING EQUIPMENT TO CONTROL HAZARDOUS MATERIALS SPILLS

## INTRODUCTION

The following unit has been organized to present in limited detail a summary of (1) the definition and individual applicabilities of open, semi-closed and closed testing; (2) the evaluation of these elements in relation to the Northeastern Buffer Zone Site, the Southeastern Buffer Zone Site, and the North-Central Fee Area Site; (4) the evaluation of a multi-dimensional test facility in relation to single element test facilities at the MTF; and (5) general cost considerations of each of the elements. These items are presented in expanded format as a supportive text to Section 5 of the main body of the report "Analyses of Test Elements Applicable to a Program of Testing, Demonstrating Equipment to Control Hazardous Materials Spills."

Test Elements: Open, Semi-Closed and Closed

In terms of large scale testing of equipment to control hazardous materials spills, there are three possible test elements to be considered: (1) open, (2) semi-closed, and (3) closed testing. The following text presents a brief description of each of the testing elements.

### Open Testing

Open testing involves the use of facilities which require a minimum of construction for material containment and maximizes the use of the open or ambient environmental conditions. In terms of the MTF, typical open tests could involve (1) the use of ponds, streams or bays for simulated water spills/clean-up demonstration (no modification of existing body of water); (2) the use of low-lying, mucky areas for soils contaminant/decontamination studies; (3) the use of isolated sandy lenses ("perched" surface formations underlain by impermeable clays) for groundwater movements/purging studies; and (4) the use of natural vegetation in various biotic uptake/detoxification studies. Other studies are also feasible; the major limiting factors include (1) the economics of an open element demonstration (the use of natural features means a testing program utilizing scattered and very often undeveloped sites), (2) the principal of universality in respect to other MTF uses (the use of ponds, streams and especially the Canal System means potential program conflicts with transportation, security and research uses by NASA and other MTF tenant agencies), and (3) the controllability of the tests (accidental releases of hazardous materials must be capable of being controlled, in order not to endanger the human and ecological aspects surrounding the test site area).

## Semi-Closed Testing

Semi-closed testing involves the use of facilities that permit isolation of the tests from the open environment to some degree, but does not provide for complete containment in closed environmental chambers. The test is therefore partially divorced from the ambient environment, and utilizing devices such as impermeable liners (for example, plastic) to eliminate potential groundwater contamination. Again, in terms of the MTF, typical semi-closed tests could involve (1) the use of diking or grout curtains to contain hazardous materials within a captive area (soils or hydrologic simulation for demonstration/testing of certain types of equipment); (2) the use of various incineration devices (with appropriate air contamination controls); (3) the use of greenhouses, aquaria, or other laboratory-like structures; and (4) the use of inflatable plastic domes to study air contaminant/biotic purging. Again, consideration of semi-closed testing involves limitations such as: (1) the economics feasibilities involved in land modification and construction; (2) the design and implementation of adequate (and appropriate) controls to ensure safety in terms of accidental hazardous materials releases; and (3) the test site(s) selected will be modified by construction activities of previous tests, thus a larger site(s) with capabilities of physical plant (and/or specific site) expansion must be considered.

## Closed Testing

Closed testing involves facilities within which large scale tests of equipment to control hazardous materials spills can be conducted -- completely divorced from the ambient environment. The total containment of hazardous materials test procedures in an artificial environment minimizes any possible exposures to the surrounding site area. Typical closed facilities include completely sealed environmental chambers or modules, within which a wide variety of aquatic and terrestrial conditions can be controlled and simulated. This would be especially desirable for testing extremely volatile, toxic or otherwise hazardous agents. Limitations for use of such a system of testing at the MTF include (1) the cost of construction of facility or facilities (environmental chambers or modules); (2) the cost of maintenance and operation of the facilities; (3)the use of a simulated environment means that "real life" conditions (or accuracy of test results) are limited to present technology (e.g., plant/air contaminant studies in greenhouse conditions do not usually correlate with the same studies under ambient conditions -- this is partially due to the lack of synergistic agents such as variant background air quality, etc.); and (4) the controls of such a system must ensure constant containment of the hazardous material within the unit, (i.e., a breakdown in an air-scrubber device could mean an unwanted dispersion near the test module).

## EVALUATION OF THE OPEN, SEMI-CLOSED AND CLOSED TESTING ELEMENTS IN RELATION TO THE MTF AND CANDIDATE SITES

This unit is subdivided into: (1) a discussion of the three test elements in relation to the MTF as an entity (or any given location at the MTF), and (2) an evaluation of the test elements in relation to the proposed candidate sites. Information developed in this unit will be expanded in more detail in other sections where cost-estimates and schematic test designs are presented.

### General Site Considerations

Table 28, the General Evaluation of Open, Semi-Closed and Closed Testing at the Mississippi Test Facility, presents an analysis of 38 criteria in relation to the three test elements if installed at any given location at the MTF. The numerical symbols used in the evaluation have the following meanings:

- The symbol (1) indicates the system was rated as the most preferred of the three possibilities for a given criterion.
- The symbol (3) indicates the system was rated as the least preferred of the three possibilities for a given criterion.
- The symbol (2) indicates a rating value between (1) and (3).

All criteria are rated separately, for example, legal considerations are rated separately from costs; thus, the system rated as most preferred under one criterion may be rated as least preferred in another instance. It is the reader's responsibility to weigh the individual criteria against each other. In an unweighted summation of the values in Table 28:

- Closed testing has a total of 20 points.
- Semi-Closed testing has a total of 23 points.
- Open testing has a total of 32 points.

The lowest total indicates the overall "most preferred"; the highest total indicates the overall "least preferred." This equal weighted summation is misleading in terms of:

## TABLE 28 GENERAL EVALUATION OF OPEN, SEMI-CLOSED AND CLOSED TESTING AT THE MTF

| | Criteria | Open | Semi-Closed | Closed | Comments |
|---|---|---|---|---|---|
| (1) | Policy of Congress Sec 311(b)(1) FWPC Act, and overall potential to meet legal requirements. | 3 | 2 | 1 | Stated Congressional policy of no discharge, also Clean Air Act, health hazard, public safety hazard. |
| (2) | Capital* and operating costs. | 1 | 2 | 3 | Cost for facilities: for closed--expected to be high; semi-closed--intermediate; open--lower than semi-closed. |
| (3) | Potential for contamination of ground and surface water, air, etc. | 3 | 1 | 1 | For semi-closed, test compounds are controlled and limited. |
| (4) | Adequacy of current baseline data. | 3 | 2 | 1 | Additional monitoring and measurements necessary in all systems (see Appendix C). |
| (5) | Permits test in actual environment. | 1 | 2 | 3 | Artificial test modes can never completely simulate actual conditions. |
| (6) | Status of current definitions of hazardous materials. | 3 | 2 | 1 | Profusion of classification schemes, hazard to environment, hazard to health. |

*There may be an order of magnitude difference in capital cost between semi-closed and closed elements.

TABLE 28. (Continued) GENERAL EVALUATION OF OPEN, SEMI-CLOSED AND CLOSED TESTING AT THE MTF

| Criteria | Open | Semi-Closed | Closed | Comments |
|---|---|---|---|---|
| (7) Test design: complexity, time required and personnel. | 1 | 2 | 3 | Open is expected to be less complex than semi-closed or closed; less set-up time and less personnel required for semi-closed and open, than for closed. |
| (8) Ease and rapidity of implementation. | 3 | 2 | 1 | Open and semi-closed expected to be more easily initiated than closed elements. |
| (9) Control of single-variable tests.* | 2 | 1 | 1 | Test elements are selected based on variable and hazardous nature of material. |
| (10) Control of two or more variables* during testing. | 3 | 2 | 1 | Precipitation and wind control is possible for semi-closed and closed; temperature and humidity control is possible for closed in addition to precipitation and wind. Open testing possesses minimum variable control. Control of hazard is possible for both semi-closed and closed for various categories of hazardous materials. |

*Variables considered include, but are not limited to, the following: duration of precipitation, intensity of precipitation, runoff rate, soil type, wind speed, wind direction, temperature, humidity, light period, light intensity, water quality, water quantity, etc.

TABLE 28. (Continued) GENERAL EVALUATION OF OPEN, SEMI-CLOSED AND CLOSED TESTING AT THE MTF

| Criteria | Open | Semi-Closed | Closed | Comments |
|---|---|---|---|---|
| (11) Flexibility* of experimentation. | 3 | 1 | 1 | Controlled environment enables maximum flexibility. |
| (12) Acceptability** of HMSE/MTF Program to local/state/U.S. residents, environmental groups, and MTF tenant agencies. | 2 | 1 | 1 | Generally, little or no reaction expected; this assumes proper controls designed into program tests and also assumes proper public education about usefulness and safety of the HMSE program. |
| (13) Physical and environmental failsafes.** | 3 | 2 | 1 | Probability of failure and thus detrimental effects can be reduced to low levels in controlled systems. |
| (14) Reusability of test system. | 1 | 1 | 1 | Assumes a successfully designed program, i.e., the appropriate test in the appropriate system. Extremely hazardous materials that are unpredictable in terms of control should not be tested in open systems. |

*Based on the types and numbers of tests possible in a given area, i.e., one module (closed elements) could be subdivided into chambers for several tests performed simultaneously.

**Assumes adequate controls and planning in all tests--this based on interviews conducted (Appendix E). Also, in terms of a complete failsafe [control] design of such, which is not possible in an open system.

(1) Costs, legal requirements, and failsafes might be considered more important than other criteria, and thus, a somewhat different image of overall "most preferred" is possible.

(2) For a given test program, some of the criteria might not apply, and thus a rating for control of single variable tests might be eliminated; thus changing the overall "most preferred" value.

It is also possible that the reader will weight the evaluations in regard to a specific test/test element, and not in relation to an entire HMSE program. These factors preclude further interpretation in this text.

Finally, for a given criterion as in Number 3 (Table 28), the use of a numerical symbol twice indicates our inability to distinguish differences between two elements. Thus, in Numbers 3, 9, 11 and 12, Closed and Semi-Closed testing both are rated as "most preferred"; and in Number 14, all systems are rated "most preferred." Although it was impossible to vary the rating values for these items, we felt it important to represent the criterion as accurately as possible.

In terms of an unweighted single criterion evaluation (Table 28), the following considerations are evident:

(1) Closed testing, although more costly than open or semi-closed testing, could be designed and instituted at the MTF without as extensive an additional baseline study as would be necessary for an open system facility.

(2) Design of either the closed testing, or in some cases the semi-closed testing, facilities could begin immediately upon (a) the selection of an adequate site at the MTF, and (b) the decision of what types of tests were to be performed at the facility.

(3) All three test elements would necessitate initial and continuing monitoring as well as detailed evaluations of specific environmental baseline conditions.

(4) That the cheapest designs would involve open testing, then semi-closed testing, and the most expensive -- closed testing.

(5) The safest overall test elements (multi-test component program) would be closed and semi-closed in design.

(6) In terms of a 100-acre area, closed and semi-closed testing would provide a more diversified and flexible approach to large-scale testing.

(7) The most publicly acceptable systems would be closed, and semi-closed, followed by open.

Again, these analyses involve equally weighted parameters -- much of which would be variable with type of equipment and type of material requirements for each type of test. Thus, open testing might be more desirable than closed or semi-closed testing in some instances. This factor of diversity in program design is presented later in this unit.

## The Three Test Elements in Relation to the Proposed Candidate Sites

In terms of the three sites described in Appendix C, all three test systems would be applicable providing: (a) adequate baseline monitoring is insured with each site operation, and (b) adequate controls are provided to insure safety to the surrounding areas. Feasibility therefore must be defined in terms of (1) the type(s) of tests to be performed, (2) the relative costs of developing each area for a particular type of testing, and (3) the relative benefits accrued.

Sections 5 and 6 present a brief description of the various semi-closed test elements in relation to the varied feasibilities at each of the three candidate sites. Open testing, while least expensive, would need initiation of environmental monitoring/surveillance as the essential prerequisite and definition of tests in relation to the results of the environmental monitoring/surveillance program. This would delay actual testing at the candidate site and, thus, would not meet the needs of EPA's Hazardous Materials Program. Upon completion of a 6-12 month monitoring/surveillance program (which is essential to semi-closed tests as well), open testing would be the least expensive in relation to closed or semi-closed; estimated cost ranges are given below:

| | | |
|---|---|---|
| OPEN: | (Includes excavation, pumps, piping, and minimal emergency treatment facilities.) | $50,000 - $ 150,000 |
| SEMI-CLOSED: | (Includes lined reservoirs, grout curtains, groundwater controls, underdrains, recyclced flowing systems, and a water treatment facility.) | $604,000 - $675,000 |
| CLOSED: | (Includes domes or enclosures, liners, underdrains, environmental simulators, air cleaning, incineration, earth movers, etc.) | $3,500,000 - $6,000,000 |

Thus, a semi-closed testing approach, as described in Section 7 (pp. 45-53) would provide the least costly approach in terms of EPA's Hazardous Materials testing needs. The weighted parameters analyses approach, based on findings in Appendices A - C and Sections 4-6, also indicate semi-closed testing as the most feasible alternative.

Paramount to the entire program is a successful engineering/design phase which would describe site feasibilities in more accurate terms. This report, therefore, is aimed at recommending further study as stated in Sections 1 and 2 (Recommendations and Conclusions).

## APPENDIX E

## PERSONS INTERVIEWED AND OTHER INSTITUTIONS CONTACTED FOR THE MTF EVALUATION AND SYSTEMS ANALYSES

Auter, Henry
1st Deputy Asst., NASA
Mississippi Test Facility
Bay St. Louis, Mississippi

Bailey, H.
Earth Resources Laboratory
Mississippi Test Facility
Bay St. Louis, Mississippi

Bankston, P.T.
Liaison Officer
Mississippi Research & Development
Jackson, Mississippi

Beck, Alvin
Head Administrator
Pearl River Development District
Mississippi Manufacture Building
720 N. President St.
Jackson, Mississippi

Berry, Laurie
Head Administrator
Mississippi Test Facility Master Plan
NASA-Mississippi Test Facility
Bay St. Louis, Mississippi

Blackwell, Major
Technical Escort Center
Edgewood Arsenal
Edgewood, Maryland

Blakely, Harvey
U.S. Army Corps of Engineers
Mobile District
2301 Airport Blvd.
P.O. Box 1169
Mobile, Alabama 36601

Bowden, Robert
EPA/Office of Water Programs
1 North Wacker Drive
Chicago, Illinois

Cameron, A.N.
U.S. Geological Survey
Baton Rouge, Louisiana

Cavey, Paul N.
Chemical Agent Disposal Office
Edgewood Arsenal
Edgewood, Maryland

Christmas, Y.J.
Gulf Coast Research Laboratory
Ocean Springs, Mississippi

Coffman, John
Climatological Data, EEE Area
Bldg. 4610, Room 1043
Marshall Space Flight Center
Huntsville, Alabama

Coogan, Alan
Geologist
Kent State University
Kent, Ohio

Coogan, Richard
U.S. Army Corps of Engineers
Mobile District
2301 Airport Blvd.
P.O. Box 1169
Mobile, Alabama 36601

Cooke, David W.
Assistant Director
Gulf Coast Research Laboratory
Ocean Springs, Mississippi

Eckhaus, Sigmund R.
Chief, Environmental Technology Office
Edgewood Arsenal
Edgewood, Maryland

Eleutarius, Lionel
Botanist
Gulf Coast Research Laboratory
Ocean Springs, Mississippi

Flaherty, D.A.
Chief, Office of Administrative Services
U.S. Corps of Engineers
South Atlantic Division
510 Title Bldg.
30 Pryor St., S.W.
Atlanta, Georgia

Fleming, Mary
Librarian, MTF--Technical Library
NASA-Mississippi Test Facility
Bldg. 1100
Bay St. Louis, Mississippi

Foiloux, James
Director, EPA Operations
Mississippi Test Facility
Bay St. Louis, Mississippi

Geissler, E.D.
Director, Aero-Astro Dynamics Lab.
George C. Marshall Space Flight Center
Huntsville, Alabama

Groat, Cynthia S.
Marine Biologist
Bowling Green State University
Bowling Green, Ohio

Gunter, Gordon
Director Emeritus and Editor
Gulf Research Reports
Gulf Coast Research Laboratory
P.O. Drawer AG
Ocean Springs, Mississippi

Gysel, L.W.
Dept. of Fisheries and Wildlife
Natural Resources Bldg.
Michigan State University
E. Lansing, Michigan

Hagan, John
EPA/Office of Water Programs
College Station Road
Athens, Georgia

Hendry, Michael
Hancock County Forester
Bay St. Louis, Mississippi

Howard, Douglas
Asst. to Mr. Auter
Mississippi Test Facility
Bay St. Louis, Mississippi

Howse, Donald
Director
Gulf Coast Research Laboratory
Ocean Springs, Mississippi

Johnson, Richard
Director, Mississippi State University Research Center
Mississippi Test Facility
Bay St. Louis, Mississippi

Jones, Paul
U.S. Geological Survey
NASA-Mississippi Test Facility
Bay St. Louis, Mississippi

Long, Byron
Engineer and Head of Special Projects
Mississippi Research and Development
Jackson, Mississippi

Manchego, B.J.
EPA Water Quality Monitoring
Mississippi Test Facility
Bay St. Louis, Mississippi

McCall, Jerrold
Deputy Director, Environmental Studies
NASA-Mississippi Test Facility
Bay St. Louis, Mississippi

McComas, Murray
Hydrogeologist
Kent State University
Kent, Ohio

Mooneyhan, D.W.
Earth Resources Laboratory
Mississippi Test Facility
Bay St. Louis, Mississippi

Morrill, P.A.
National Data Buoy System
Mississippi Test Facility
Bay St. Louis, Mississippi

Moser, Paul
Geologist
Alabama Geologic Survey
Tuscaloosa, Alabama

Newcome, Roy
U.S. Geological Survey
430 Bounds St.
Jackson, Mississippi

Oglesbee, Paul
EPA Pesticides--Quality Control
Mississippi Test Facility
Bay St. Louis, Mississippi

Pepper, Jack
Mississippi Board of Water Commissioners
Primos Bldg.
416 N. State St.
Jackson, Mississippi

Pullin, Thomas
Botanist
Mississippi State University Herbarium
State College, Mississippi

Ready, Donald
Geologist
Mississippi State University
State College, Mississippi

Rhyne, John
MTF Meteorological Station
Mississippi Test Facility
Bay St. Louis, Mississippi

Richardson, William
Industrial Representative
Agricultural & Industrial Board
2000 Walter Sillers Bldg.
P.O. Box 849
Jackson, Mississippi

Saltsman, E.J.
Office for State Climatology
P.O. Box 5779
Pearl Branch
Jackson, Mississippi

Sauer, Stanley
EROS, Mississippi Test Facility
Bay St. Louis, Mississippi

Schneider, V.R.
Res. Hyd. Engr., U.S.G.S.
Mississippi Test Facility
Bay St. Louis, Mississippi

Sonnenberg, H.J.
Accident Analysis Officer
U.S. Department of Transportation
Office of Hazardous Materials
Washington, D.C.

Stogner, Jean
Global Central Engineering File and Data Center
Mississippi Test Facility
Bay St. Louis, Mississippi

Svekah, H.
Earth Resources Laboratory
Mississippi Test Facility
Bay St. Louis, Mississippi

Tai, Han
EPA Pesticides Testing
Mississippi Test Facility
Bay St. Louis, Mississippi

Turner, Robert E.
Diffusion Studies
Climatological Data, EEE Area
Bldg. 4610, Room 1043
Marshall Space Flight Center
Huntsville, Alabama

Wagner, Kenneth
Director
Education and Research Center
Mississippi Research and Development
Jackson, Mississippi

Wittman, F.
Marine Fisheries
Mississippi Test Facility
Bay St. Louis, Mississippi

Wolverton, William
EPA-NASA Research
Mississippi Test Facility
Bay St. Louis, Mississippi

Woodlansi, Robert
Animal Ecologist
Gulf Coast Research Laboratory
Ocean Springs, Mississippi

## OTHER INSTITUTIONS CONTACTED

Louisiana Water Resources Research Institute
Louisiana State University and Agricultural & Mechanical College
Baton Rouge, Louisiana 70803

Lower Mississippi Valley Division
Div. Engineer, U.S. Army Engineers Division
Lower Mississippi Valley
Corner of Walnut & Crawford Streets
P.O. Box 80
Vicksburg, Mississippi

U.S. Army Engineers Waterways Experiment Station
U.S. Army Corps of Engineers
P.O. Box 631
Vicksburg, Mississippi

U.S. Coast Guard
Eighth Coast Guard District
Customhouse
New Orleans, Louisiana 70130

Weather Bureau
Regional Hydrologist
ESSA Weather Bureau, Southern Region
Federal Agencies Bldg.
819 Taylor Street
Ft. Worth, Texas